



Optimising water reuse in the EU

Final report – Part I

Prepared for the European Commission – DG ENV



In association
with



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Glossary

Advanced or tertiary treatment	Additional treatment stages after secondary treatment to remove specific constituents such as nutrients, suspended solids, organic matter, heavy metals, dissolved solids (salts, for example) or pathogens (Plan Bleu-UNEP, 2012).
Direct water reuse	Use of recycled water delivered directly for beneficial reuse including into a water supply system (Lazarova et al., 2013).
Greywater	Wastewater produced from kitchens, bathrooms and/or laundry, which normally does not have high concentrations of excreta (Plan Bleu-UNEP, 2012).
Groundwater recharge	Infiltration or injection of natural water or reclaimed water into an aquifer to replenish underground water resources or to block seawater intrusion (Plan Bleu-UNEP, 2012).
Indirect water reuse	Reuse of treated wastewater after its discharge into natural bodies of water (Plan Bleu-UNEP, 2012).
Planned reuse	Direct or indirect reuse of treated wastewater, ensuring water quality control during its conveyance through especially designed facilities and systems for treatment, storage and distribution of treated wastewater (Plan Bleu-UNEP, 2012).
Primary treatment	Treatment of urban waste water by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD ₅ of the incoming waste water is reduced by at least 20 % before discharge and the total suspended solids of the incoming waste water are reduced by at least 50 % (Directive 91/271 CEE)
Reclaimed water	Former wastewater that has been treated to remove solids, organic matter and certain types of impurities. Such water is treated to a certain quality that matches the intended use, in most cases at a lower standard than drinking water quality. In the present study, the terms 'reused water' and 'recycled water' are used synonymously with the term 'reclaimed water'.
Secondary treatment	Treatment of urban waste water by a process generally involving biological treatment with a secondary settlement or other process in which the requirements established in Table 1 of Annex I are

respected (Directive 91/271 CEE).

Standards on water reuse	Different types of documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that water reuse projects achieve an acceptable level of health and/or environmental protection (adapted from the ISO definition is in line with the ISO definition of a standard).
Treated wastewater reuse	Beneficial reuse of appropriately treated wastewater (Directive 91/271 CEE). In the present study, the terms 'water reuse' and 'water recycling' are used synonymously with the term 'treated wastewater reuse'.
Unplanned reuse	Uncontrolled reuse of wastewater after discharge. An example of unplanned reuse of wastewater is when effluents are discharged upstream in a river whose waters are used downstream for water supply of urban networks and/or for irrigation (Plan Bleu-UNEP, 2012).
Urban wastewater	Domestic water or the mixture of domestic wastewater with industrial wastewater and/or run-off rain water (Directive 91/271 CEE). In this context, domestic wastewater does not contain industrial effluents at levels that could pose threats to the functioning of the sewerage system, treatment plant, public health or the environment.
Water scarcity	Water scarcity occurs where there are insufficient water resources to satisfy long-term average requirements. It refers to long-term water imbalances, combining low water availability with a level of water demand exceeding the supply capacity of the natural system (EEA).
Water stress	Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.) (EEA).

Executive Summary

Europe's freshwater resources are under increasing stress, with a worrying mismatch between demand for, and availability of, water resources across both temporal and geographical scales.

Water stress affects one third of the EU territory all year round (EC, 2012). During summer months water scarcity is more pronounced in Southern European river basins but is also becoming increasingly important in Northern river basins, including UK and Germany. The frequency and intensity of droughts and their environmental and economic damages appear to have increased over the past thirty years (EC, 2012). Water over-abstraction, particularly for irrigation purposes but also for industrial use and urban development, is one of the main threats to the EU water environment. This is not only an issue for arid regions with low rainfall and high population density that are prone to increasing water stress; temperate areas with intense agricultural, tourism and industrial activities also suffer from frequent water shortages and/or expensive supply solutions. Global climate change is already exacerbating these problems with projections indicating significant and widespread impacts over the medium to long term. Growing competition for water resources between different water using sectors is already emerging, and there is a need for high quality resources to be protected and reserved for drinking water supply. As a result, water scarcity is expected to affect in 2030 about half of EU river basins (EEA, 2012b).

As an alternative water supply option, water reuse has emerged as an issue requiring EU attention.

To address the water scarcity issue, a number of actions are listed in the European Commission's Communication 'A Blueprint to Safeguard Europe's Water Resources' (the 'Blueprint')¹. Among these actions, the EU plans to take measures to develop additional water supply options, among which water reuse, once all other improvements in efficiency on the demand side are exhausted. Water reuse may have a lower environmental impact than other alternative water supplies (e.g. water transfers or desalinisation) and may offer a range of environmental, economic and social benefits. This option, however, has been developed only to a limited extent in the EU.

The Commission is evaluating the most suitable EU-level instruments to encourage water reuse, with a view to make a policy proposal by the end of 2015, subject to an Impact Assessment (IA).

This study provides support to the Commission in the preparation of this IA, by characterising the problem to be addressed, proposing a set of policy options to address the problem drivers and assessing their environmental and socio-economic impacts. The study focuses on the reuse of urban and industrial wastewater for various possible applications (agricultural irrigation,

¹ COM(2012) 673

urban uses, industrial uses, recreational and environmental uses, potable water production, etc.)². It follows the approach detailed in the Commission's IA Guidelines. The analysis is based on a thorough review of available literature, consultation of experts and stakeholders, including the CIS working group on 'Programmes of Measures', and a public consultation³.

The problem to be addressed by future EU action is as follows: although there is a growing scarcity affecting most of EU waters with consequences on the environment but also all water users, the potential for reusing water remains largely untapped.

Water reuse is an accepted practice in several EU Member States (MS), in particular those subject to the most significant water scarcity issues (e.g. Cyprus, Spain, Italy, Malta). The current volume of reused water in the EU can be roughly estimated at 1,100 Mm³/y, accounting for about 2.4% of treated urban wastewater. ES accounts for almost half of it, followed by IT (approx. 233 Mm³/y in 2006) and, to a much lesser extent, FR, DE, PT and EL. In EL, IT and ES, water reuse constituted only 5 to 12% of treated urban effluents in 2006, while much higher rates are encountered in Cyprus (almost 100%) and Malta (about 60%). It is important to note that estimates of water reuse volumes are associated with high uncertainties, as MS seem to have different interpretations of what should be considered and officially reported as 'water reuse'⁴.

Given the small proportion of treated wastewater that is currently reused in the EU, there is significant potential for increasing the total volumes of reuse. The contribution of water reuse to addressing water scarcity could therefore be greatly enhanced.

Recently collected information shows that water reuse is not expected to increase significantly over the next 10 years, if no further EU policy actions to promote it are implemented. Under a business as usual (BAU) scenario, it is roughly estimated that water reuse could reach a level of 1,700 Mm³/y by 2025, mostly driven by increased uptake in Spain.

Six main types of barriers to a wider uptake of water reuse solutions have been identified; inadequate water pricing and insufficient control over freshwater abstraction being considered the most significant ones.

1) Inadequate water pricing

There are insufficient price differentials between reused water and freshwater, exacerbated by a lack of full cost recovery within most EU water markets and the existence of public subsidies to conventional water resources in many EU areas. This is both a regulatory failure (improper implementation of Art. 9 of the Water Framework Directive (WFD)) and a market failure as prices of conventional resources and reused water do not reflect their actual cost. This situation leads to a limited economic attractiveness of water reuse projects and improper decisions by water users and decision makers. The required EU policy actions to address this problem driver extend well beyond the issue of water reuse. EU actions to better enforce the water pricing provisions of the WFD are included in the Blueprint (e.g. development of further guidance on cost recovery), but a large part of the enforcement efforts lies with the national and regional authorities.

² Internal recycling and unplanned reuse are not covered by the study.

³ The consultation took place from 30 July to 7 November 2014.

⁴ E.g. volumes corresponding to internal water recycling in the industry, or to planned indirect reuse, may or may not be included in the reported data, depending on the MS

2) Insufficient control over freshwater abstraction

There are many situations where access to conventional water resource is insufficiently controlled by public authorities, resulting in both over-allocation (abstraction permits going beyond available resources, including situations where no maximum amount is set in permits) and illegal abstraction (when permits are not enforced, in particular because of no monitoring of actual abstractions). This issue can be considered as a regulatory failure (improper implementation of the WFD provisions). EU actions to prevent over-allocation and illegal abstraction were proposed in the Blueprint, however a large part of the enforcement efforts still lies with the national and regional authorities.

3) Economic and technical uncertainties for decision-makers

There are a number of information, regulatory and technical failures, as well as societal issues, which limit consumer willingness to pay for reused water and hence its ability to compete with freshwater resources:

- A lack of stakeholders' awareness concerning the benefits of water reuse;
- A lack of public acceptance towards water reuse;
- A fear of potential trade barriers on agricultural goods that have been grown using reclaimed water; and
- In some MS where no water reuse standards are in place, a lack of clarity in the regulatory framework to manage health and environmental risks.

These issues create uncertainties for potential project developers or investors interested in water reuse.

4) Too stringent water reuse standards for the intended uses, in some MS

In FR, IT and EL, the level of stringency of the existing water reuse standards has been reported to be an obstacle to the further uptake of water reuse solutions, due to high administrative burden and associated costs for local authorities, reclaimed water suppliers and users. The situation is likely to remain unchanged in future years (i.e. very few new water reuse projects) in the absence of EU action related to standards' harmonisation and simplification.

5) Reuse not seen as a component of integrated water management approaches

Integrated water management is not sufficiently implemented and still in its infancy in certain EU regions. In particular, this is characterised by: a fragmentation of responsibilities for and authority over different parts of the water cycle; and a lack of communication and cooperation among stakeholders involved in the whole water cycle in certain EU regions, in particular between water supply and sanitation stakeholders. This can be considered as a regulatory failure. Despite the recommendations in both the Water Framework and Urban Waste Water Treatment Directives, reuse is rarely considered in the design and location of waste water treatment plants.

6) Technical challenges and scientific uncertainties

The water reuse sector in the EU seems to be mature, technical solutions are well-known and available to cover a wide range of applications and environments. These solutions, however, are not always cheap and there remain a few technical challenges, in particular: the removal of emerging contaminants (pharmaceuticals, drug metabolites, household chemicals, etc.) by conventional treatment techniques, the need for rapid monitoring techniques that are reliable and cost-effective, or the issue of saline intrusion in obsolete sewage systems in coastal areas.

To address these problem drivers, future EU action should aim to achieve a higher uptake of appropriate water reuse solutions, where it proves cost effective, while ensuring the safety of reuse practices and avoiding potential internal trade barriers for food products.

This general policy objective is complemented by eight specific objectives:

- Promote an increased use of economic instruments to make water reuse schemes more economically attractive;
- Build trust, credibility and confidence in the quality of reclaimed water among the general public;
- Provide clarity on how to manage public health and environmental risks of water reuse projects in the EU;
- Promote water reuse as an integral part of integrated water management;
- Increase knowledge on the benefits of water reuse among the various stakeholders;
- Avoid potential internal trade barriers for agricultural products irrigated with reclaimed water;
- Create a level playing field for reclaimed water users across the EU; and
- Improve scientific knowledge and technical expertise in the field of water reuse.

Four policy options have been investigated, including legally-binding and non-binding options

Under **Option 0** (the ‘no policy change’ option, or BAU scenario), no further EU policy actions to promote water reuse would be taken. However, existing EU policy measures aiming to support water reuse would be continued, in particular support to innovation through the European Innovation Partnership on Water, funding of research projects on water reuse and funding of water reuse projects through the European Structural and Investment Funds.

Option 1 is a package of **non-binding information, communication and knowledge enhancement measures**:

- Development of a **harmonised set of definitions and Key Performance Indicators** for the reporting of water reuse data across the MS and improved national reporting of reused water volumes through Eurostat.
- **Awareness raising campaigns, development of awareness raising tools and dissemination of information** on the various benefits of water reuse, among all key stakeholders.
- Development of a **good practice reference document on water reuse**, resulting from a knowledge exchange between MS and other stakeholders, and of **guidelines on how to foster water reuse through economic instruments**. These guidelines would support the design and implementation of the right price structure and level for water reuse.

- **Promotion of forthcoming ISO/CEN water reuse standards by the EU**, as a common referential to be used by the MS for the management of health and environmental risks⁵.
- Development of **guidelines on the implementation of the WFD and UWWTD**. These guidelines would:
 - Clarify the requirements of Art. 12 of the UWWTD⁶ and provide guidance to MS on how to enforce this article, especially when treatment plants are built or upgraded;
 - Provide guidance on cases where water reuse should be given priority among alternative water supply options; and
 - Encourage water stressed MS to assess the contribution water reuse can make under different water stress scenarios and, if this contribution is significant, to have agreed targets for the use of reclaimed water as part of their river basin management plans.

Option 2 consists of **legally-binding EU standards on water reuse**, covering uses for which no EU standards currently exist. Three sub-options are proposed:

- **Option 2A. Legally-binding quality criteria** – i.e. defining a range of water quality parameters with minimum thresholds that the water produced from a reuse scheme must meet. These quality parameters would be tailored to specific categories of water use such as irrigation of particular agricultural products or non-potable urban uses.
- **Option 2B. Legally-binding risk assessment and management framework** – i.e. defining a planning and management process that reuse scheme operators must undertake in order to obtain approval for their schemes.
- **Option 2C. Legally-binding technological criteria** – i.e. defining a set of pre-approved or certified treatment technologies for reuse schemes⁷.

Option 3 consists of a **legally-binding requirement for MS to assess the contribution that water reuse can make to address water stress** and, if this contribution is significant, to have **agreed targets** for use of reclaimed water as part of their river basin management plans (RBMPs). For example, the targets could be expressed as a given percentage of the reclaimed water produced within the river basins (see the Catalan⁸, Portuguese⁹ and Australian¹⁰ examples) or a given percentage of the total water withdrawals within the river basins. Some flexibility would be left to MS in order to take into account the local geographical and socio-economic context of their river basin in their decision to set up the targets (e.g. distance between offer and demand).

⁵ ISO standards on water reuse for agricultural irrigation are expected to be published for 2015, while there is not yet any defined timeframe for the publication of ISO standards covering other uses.

⁶ In particular, specifying what is meant by '*Treated waste water shall be reused where appropriate*'

⁷ Such as the Title 22 certification system in California

⁸ The Catalan Water Agency set a target of 31% of water reuse by 2015, after having assessed the reuse opportunities around the main urban waste water treatment plants (see Annex E for more details)

⁹ In Portugal, 10 % of wastewater was to be reused by 2013 (but this target was not achieved)

¹⁰ The Australian Government itself committed to a national target of recycling 30% of wastewater by 2015. In addition, many major cities and several states have set targets to achieve specific percentages of wastewater recycling (see Annex E for more details)

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1.Introduction

In this introductory chapter, the overall context and rationale underlying the study is summarised together with the project objectives and the overall methodology.

1.1 Context of the study

Europe's freshwater resources are under increasing stress, with a worrying mismatch between demand for, and availability of, water resources across both temporal and geographical (spatial) scales (EEA, 2012a). **Water stress** affects **one third** of the EU territory all year round (EC, 2012). During summer months **water scarcity** is more pronounced in Southern European river basins but is also becoming increasingly important in Northern river basins, including UK and Germany. Even in areas where water stress indicators are well below the thresholds, water saving is an important concern, in particular for domestic consumption, due to the energy consumption linked with water distribution, use and treatment. The frequency and intensity of **droughts** and their environmental and economic damages appear to have increased over the past thirty years (EC, 2012). South-eastern Europe is increasingly facing extended periods of droughts, and both Northern and Western Europe have been affected in more recent years (EEA, 2012a).

Resource availability is further compromised by **poor or unsuitable water quality** which can significantly increase the financial costs of supply. This is not only an issue for arid regions with low rainfall and high population density that are prone to increasing water stress; temperate areas with intense agricultural, tourism and industrial activities also suffer from frequent water shortages and/or expensive supply solutions (Rodriguez et al., 2007a). **Global climate change** is already exacerbating these problems with projections indicating significant and widespread impacts over the medium to long term (EEA, 2005). Growing competition for water resources between different water use sectors is already emerging, with **high quality resources being protected** and reserved for drinking water supply. In addition, **resource efficiency** is a key policy objective of the European Commission – as exemplified by the flagship Resource Efficiency Roadmap¹¹ – with water itself being targeted as a key resource. Protecting water resources also have benefits for other resources such as biodiversity, soil or energy.

Europe's ability to respond to the increasing risks of water scarcity and drought could be enhanced by **wider reuse of treated wastewater** for agricultural, industrial and urban uses in particular. Water reuse is an accepted practice in several EU countries subject to water scarcity issues (e.g. Cyprus, Spain, Italy), where it has become an integral and effective component of long-term water resources management. Water reuse may have a lower environmental impact than other alternative water supplies such as water transfers or desalination, under certain conditions, and may offer a range environmental, economic and social benefits. At present, however, the **uptake of water reuse solutions remains limited** in comparison with their

¹¹ COM(2011) 571

potential. This appears to be due to a number of factors, including low economic attractiveness of reuse solutions, low public acceptance of reuse solutions and limited awareness of its benefits, a lack of common EU environmental/health standards for reused water, and poor coordination of the professionals and organisations who design, implement and manage such schemes.

The European Commission's Communication '**A Blueprint to Safeguard Europe's Water Resources**'¹² (hereafter, the 'Blueprint') identified water reuse for irrigation or industrial purposes as an alternative supply option requiring EU attention. The long-term aim of the Blueprint is to ensure availability of good quality water for sustainable and equitable water use. The approach of the Blueprint focuses on: achieving good status in EU water bodies by 2015 as a rule, or by 2027 at the latest for specific water bodies covered by the Water Framework Directive (WFD) exemptions; reducing water stress taking into account the need to maintain ecological flows at a level compatible with the achievement of WFD objectives; and reducing vulnerability to climate change and extreme events. The Blueprint identified four preliminary policy options in order to ensure a further uptake of water reuse (see Box 1 below), including a regulatory instrument on standards for water reuse. These policy options all seek to '*stimulate the reuse of waste water in agriculture as a means of providing an alternative water supply and so reduce the pressure on surface and ground water sources and provide stable supply to users in times of scarcity and drought*'. The conclusions of the preliminary analysis carried out in the Impact Assessment of the Blueprint are presented in Box 1.

Box 1: Conclusions on policy options' assessment in the IA of the Blueprint (EC, 2012)

'Voluntary standards (option 7a1)'¹³ developed at EU level would provide a basis for a common approach, but the option cannot prevent Member States adopting a different approach and, therefore, cannot prevent barriers in the internal market'¹⁴.

CEN standards (option 7a2) might be more likely to be adopted by Member States, but they suffer the same flaw as option 7a1.

A Regulation (option 7b) does not have this problem and would guarantee that internal market barriers would not arise. The development of each of these options has similar costs, although the direct applicability of a Regulation would have lower burdens on Member States as it would not require transposition. The public consultation and stakeholder views all show more support for a binding Regulation as the effective means to overcome the problem compared to the other options. The option would be fully coherent with other EU water law and policy.

Option 7d (funding) is not an alternative to the other options, but can accompany any of the other options. Given public and private expenditure constraints, investment in water treatment and distribution for irrigation is constrained in some regions. Areas eligible for Cohesion Funds and EIB loans can benefit from additional investment support. The effectiveness of this option (and the resulting economic, social and environmental impacts) would be directly proportional to the level of available investment.'

¹² COM(2012) 673

¹³ Corresponding to the development of CIS guidance

¹⁴ Issues related to the internal market are further developed in the problem definition in Section 2.4

'Regarding water re-use, there is a need to ensure the effective operation of the internal market to support investment and use of re-used water. The assessment, including stakeholder consultation, found that this can only be achieved through the development of new regulatory standards at EU level. Therefore, the preferred option is for the Commission to pursue appropriate health/environment protection standards for re-use of water and, subsequently, to propose a new Regulation containing these subject to a specific impact assessment.'

1.2 Objectives of the study

As a follow-up to the Blueprint, the European Commission (EC) aims to evaluate the **most suitable EU-level instruments to encourage water reuse**, including the possibility of a Regulation establishing common standards. In 2015, the Commission intends to make a policy proposal, subject to an appropriate Impact Assessment (IA).

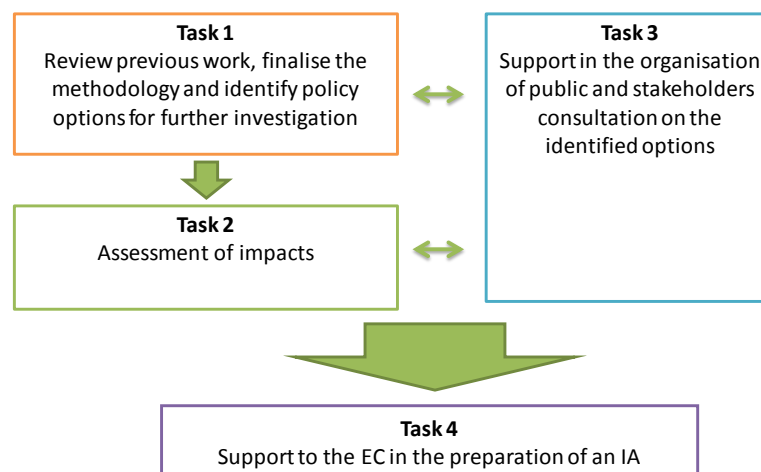
The present study **provides support to the Commission in the preparation of this Impact Assessment**, by identifying the problem drivers, defining policy objectives for the EU, proposing a set of policy options, assessing their environmental and socio-economic impacts and concluding on the most desirable options.

A secondary objective of the study is to provide support to the Commission for the **stakeholder/public consultation** associated with the preparation of the Impact Assessment.

1.3 Approach

The methodology for this study closely follows the Commission's guidelines on Impact Assessment. The study includes four main tasks as shown in the figure below.

Figure 1: Task diagram



In **Task 1**, the problem to be addressed was defined and characterised, and the baseline scenario for the impact assessment was developed, based on a thorough review of previous work on the topic and exchanges with stakeholders. Over the past few years, the Commission funded several key research projects and studies aiming to increase the knowledge base on water reuse in the EU. The present study complements and updates the previous findings, by analysing the most recent data at EU and Member State (MS) level. It also provides a comparison of water reuse standards developed by the EU MS (CY, EL, ES, FR, IT, PT) and by

key non-EU countries or organisations, which aims to inform the development of future EU policy options in this regard. In line with the key issues identified in the problem definition, policy objectives were defined and a shortlist of policy options proposed for further analysis.

In **Task 2**, the selected policy options were assessed for their economic, social and environmental impacts. First of all, the list of indicators from the Commission's IA Guidelines was screened and those relevant to the study were investigated further. The environmental and socio-economic impacts of the policy options were then described, using qualitative information as well as quantitative data where possible. The analysis took into account information on the effects of similar policy measures on water reuse implemented elsewhere, where such information was available. The limitations of the current data sets and the data gaps were analysed, and possible solutions to address these gaps identified.

Task 3 (consultation) was run in parallel to Tasks 1 and 2. It included:

- A consultation of the CIS Working Group 'Programmes of Measures';
- A public consultation (running from 30 July until 7 November 2014) with a questionnaire and background document available on the internet to any interested person, using the IPM system of the Commission;
- A consultation of targeted external stakeholders; and
- An inter-service consultation.

External stakeholders were consulted through informal exchanges all along the project. Given the limited reliability of MS-specific information available at the start of the project and the lack of up-to-date quantitative data, the project team carried out a consultation of MS and other key stakeholders during the first half of the study, in order to obtain a good evidence basis for the problem definition and baseline scenario. The interim results of the study were presented and discussed at three meetings of the CIS Working Group on 'Programmes of Measures'. Members of this group were also asked to respond to a questionnaire and to send relevant information. Questionnaire replies and/or related information were received from: AT, BE (Flanders), CZ, CY, DE, EL, ES, FI, FR, LT, LU, IT, MT, PT, RO, SE, SK, and the UK. Follow-up telephone discussions to obtain clarification and complementary information were held with representatives of FR and IT. In addition, telephone interviews based on targeted questionnaires were held with the following key stakeholders: EUREAU, the Water supply and sanitation Technology Platform (WssTP), the WHO, the French federation of the water treatment industry (SYNTEAU), two operators of large reuse schemes (Torrele IPR scheme in BE and the Old Ford scheme built for the London Olympic Park) and experts in PT (Instituto Superior de Engenharia de Lisboa) and EL (University of Crete). The EIP Water provided written comments. Finally, a meeting with representatives of Suez Environment and the International Water Association (IWA) was held.

Commission's services were consulted via an inter-service consultation meeting (November 2013) and a meeting of the IA steering group (December 2014). They were also given the opportunity to comment on project deliverables.

In **Task 4**, the project team supported the Commission in drafting the first chapters of the IA report.

1.4 Document structure

Following this introduction, the document is structured as follows:

- Chapter 2 describes the problem to be addressed, the baseline scenario (i.e. what would happen in the absence of further EU action on water reuse) and the rationale for EU action; and
- Chapter 3 defines the objectives of EU action and proposes several policy options for further investigation.

Supporting information is provided in the annexes. It includes, in particular, further details on water reuse practices and the policy context in the MS and in selected non-EU countries.

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2. Problem definition and baseline

After defining the scope of the study, this chapter describes the current situation and future trends with regard to water reuse in the EU, characterises the problem to be addressed and analyses the barriers to the wider implementation of water reuse practices. It then describes the current policy context, the current situation with regard to environmental and socio-economic aspects of the problem, as well as the likely evolution of these aspects in the absence of any further EU policy action. Finally, the rationale for EU action is explained.

2.1 Scope of the study and key definitions

2.1.1 Types of water to be reused

The present study first focuses on the **reuse of urban wastewater that is treated after collection**, having been subject to **secondary treatment** at least. The Urban Waste Water Treatment Directive (UWWTD)¹⁵ defines ‘treated wastewater reuse’ as the ‘beneficial reuse of appropriately treated wastewater’. The present study uses the wording ‘**treated wastewater**’ or ‘**reclaimed water**’¹⁶. The term **water recycling** is generally used synonymously with **water reuse**.

Under the same Directive, urban wastewater is defined as ‘domestic water or the mixture of domestic wastewater with industrial wastewater and/or run-off rain water’. In this context, domestic wastewater does not contain industrial effluents at levels that could pose threats to the functioning of the sewerage system, treatment plant, public health or the environment.

Reclaimed water is usually defined as former wastewater that has been treated to remove solids, organic matter and certain types of impurities. Such water is treated to a certain quality that matches the intended use, in most cases at a lower standard than drinking water quality.

It should be noted that the International Standardization Organisation (ISO) is currently working on a definition of water reuse, as part of the development of the ISO ‘Guidelines for treated wastewater use for irrigation projects’.

The implementation of the UWWTD has resulted in an increased amount of treated wastewater which is suitable as a source for reuse. The main objective of urban wastewater treatment plants (WWTPs) is to remove suspended solids, organic matter, and, in sensitive areas, also nutrients prior to discharge of the water to a receiving water body (typically a river). These are the key families of pollutants regulated by the Directive for discharging treated wastewater to the environment. In order to comply with the Directive’s requirements, in general a two-step treatment process is necessary (‘primary treatment’ followed by ‘secondary treatment’). When

¹⁵ Directive 91/271 CEE concerning urban waste water treatment

¹⁶ It should be noted, however, that there is a slight difference between both terminologies: ‘Reclaimed water’ usually refers to wastewater that has been subject to tertiary treatment (at least), while ‘treated wastewater’ usually refers to secondary treated wastewater as defined by the UWWTD.

treated wastewater is to be reused, in most cases there is a need for additional treatment in order to minimise health and environmental risks and adjust the water quality to the foreseen use. This additional treatment step, called 'tertiary treatment', mainly consists of the removal of pathogens and chemical contaminants. When treated wastewater is directly reused for the production of drinking water, then further treatment is required, using more advanced filtration methods for example.

Given the advanced level of technology in wastewater treatment and the diversity of techniques available, it is worth noting that secondary treated wastewater can have a bacteriological quality that is similar to surface freshwater and even sometimes better than some surface water bodies (AFSSA, 2008).

The present study also covers the **reuse of industrial wastewater** for **external** applications. Internal recycling is not within the scope, as it is already supported by a number of national and EU policy measures.

The reuse of rainwater and of greywater (e.g. for domestic purposes such as toilet flushing) is not within the scope of the study. A previous study for DG ENV on the Water Performance of Buildings (BIO, 2012) investigated the possible impacts of an EU certification scheme to promote rainwater harvesting and water reuse in buildings. It concluded that such a policy measure could achieve more than 5% reduction in potable water use by 2050 but would be mostly relevant for new buildings (and possibly for to be renovated buildings, in certain cases). It also concluded that the environmental benefits of such solutions can vary a lot from one project to another and that an integrated approach was needed in order to determine the potential carbon benefits and/or drawbacks of rainwater harvesting and greywater recycling schemes (as such systems involve the construction of a secondary pipeline with additional raw materials, compared to a direct connection to the public water supply). Therefore, in order to promote the reuse of rainwater and greywater, EU policy instruments related to the ecodesign of buildings are considered to be more suitable than water policy instruments.

2.1.2 Water reuse applications

The study covers the wide range of reuse applications of treated urban or industrial water:

- **Agricultural irrigation** such as irrigation of crops (food and non-food) and pastures;
- **Industrial uses** such as cooling water, process water, aggregate washing, concrete making, soil compaction, dust control;
- **Non-potable urban uses** such as landscape irrigation (public parks, sporting facilities, golf courses, private gardens, roadsides, etc.), street cleaning, fire protection systems, vehicle washing, toilet flushing, air conditioners, dust control;
- **Environmental and recreational uses** such as recreational impoundments (e.g. for fishing, boating, bathing), aquatic ecosystem restoration or creation of new aquatic environments, stream augmentation, aquifer recharge (for saline intrusion control and delayed abstraction to increase water resources in quantity and quality), aquaculture, artificial-snow production;
- **Increasing water availability for (later) potable water production**, through the deliberate incorporation of reclaimed water into a raw water supply such as a river, catchment reservoir or aquifer resulting in mixing and assimilation thus providing an environmental buffer (before potable treatment).

Depending on the intended application and the initial quality of the reclaimed water, additional treatment of the reclaimed water may be required to adjust its quality to the application-specific requirements. A wide variety of additional treatment processes are available to respond to different applications and different economic and environmental contexts. An overview of water reclamation technologies is available in Deliverable D19 of the EU-funded AQUAREC project (Hochstrat et al., 2006).

A distinction is often made between **direct** and **indirect** reuse of water, especially in the case of drinking water production. In such a case, **direct** wastewater reuse involves the piping of reclaimed water into a water supply system (usually following advanced purification steps) without first being incorporated in a natural stream or lake or in groundwater. **Indirect** wastewater reuse involves the reuse of treated wastewater after its discharge into natural bodies. In EU MS, as in most of the highly populated developed countries, **indirect potable reuse** through groundwater recharge and surface water augmentation, along with new infrastructure approaches, is a common situation.

A distinction also needs to be made between **planned** and **unplanned** reuse (or intended vs unintended reuse). Planned reuse corresponds to water reuse schemes that are developed with the goal of beneficially reusing a recycled water supply. **Unplanned** reuse corresponds to uncontrolled reuse of wastewater after discharge. An example of unplanned reuse of wastewater is when effluents are discharged upstream in a river whose waters are used downstream for water supply of urban networks and/or for irrigation.

The present study only covers **planned water reuse** (whether direct or indirect).

2.2 Water reuse in the EU: current and future trends

2.2.1 Current status

Overall situation

Although Europe as a region is not considered to be at risk from widespread water scarcity, there are significant differences between individual MS in terms of water security and water resource risk. It is well known that Mediterranean regions have limited rainfall and very limited water resources; furthermore, some central and northern European countries have recently been affected by extreme drought (EEA, 2012b). Rising demands and competition between different sectors, coupled with long-term concerns regarding the impacts of a changing climate on water resources and water demand, highlight the growing risks related to water availability across Europe.

Many northern European countries have sufficient water resources and therefore, the need for extra supply through water reuse is not considered a top priority at the moment. Despite this, the industrial sector is generally encouraged to recycle water and to reuse reclaimed wastewater (TYP SA, 2013) and many examples of reuse schemes can also be found in other sectors. In southern European countries, extra supply from water reuse can bring significant benefits to agriculture (e.g. crop irrigation) and tourism (e.g. golf course irrigation) in particular (Rodriguez et al., 2007b).

Until recently, water management has been dealt with at sectoral level (urban, industrial or agricultural) and seldom at a larger spatial scale, accounting for interactions at river basin level in terms of quality as well as quantity (WssTP, 2013). Nevertheless, many professionals in the water sector are aware of the numerous possibilities of exchanging secondary water resources

from one sector to another. Such water trades first occurred in water scarce regions in which dedicated schemes and regulation have subsequently been developed (e.g. Israel, Australia, Tunisia, Cyprus, California). Some European countries that have experienced frequent water scarcity have similarly developed water reuse as a key component of their long-term water resources management strategy (TYP SA, 2012).

At present, data on volumes of reused water in the different MS is not comprehensive and up-to-date, although MS are required to report the volumes of reused urban treated wastewater to the Commission in application of the UWWTD. Furthermore, the water treatment industry does not publish any comprehensive data on volumes of reused water.

In addition, the available data is of limited reliability, due to the fact that¹⁷:

- MS seem to have different interpretations of what should be considered as 'water reuse' (e.g. volumes corresponding to internal water recycling in the industry, or to planned indirect reuse, may or may not be included in the reported data, depending on the MS); and
- Some of the reported data may refer to volumes of reclaimed water produced for reuse, while others may refer to actual consumption of reclaimed water by the users (and there may be differences between supply and end use).

In addition to the limited data reported under the UWWTD, estimates of water reuse volumes were developed through modelling work carried out as part of the EU-funded AQUAREC project (Hochstrat et al., 2006), however these estimates date back to 2006 and are associated with a number of limitations.

The available sources of data are discussed in the next paragraphs. This is complemented by an overview of water reuse practices in the MS, in Annex A.

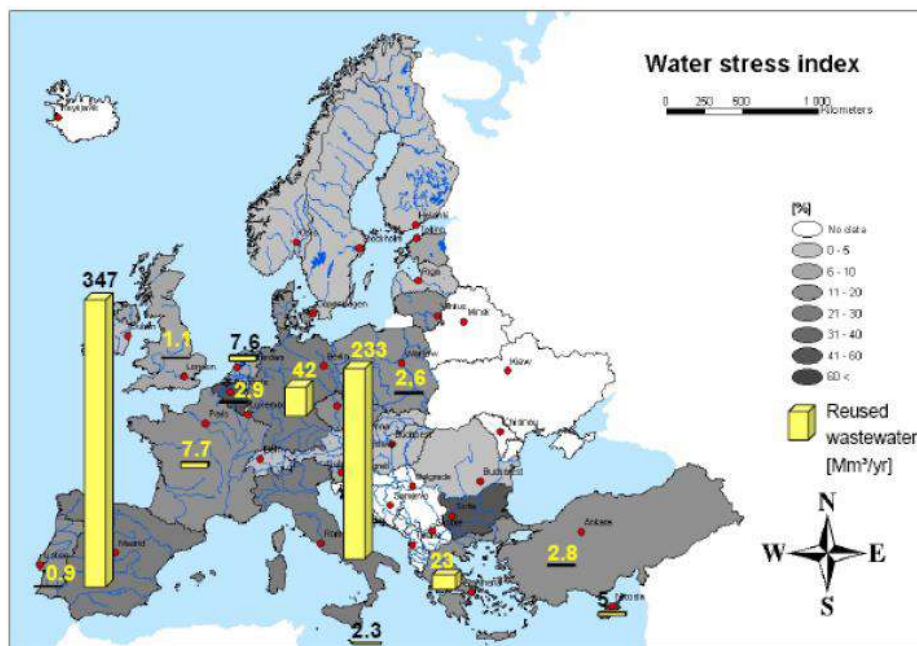
Information from previous reports for DG ENV

Reports on Wastewater Reuse in the EU were prepared for DG ENV in 2012 and 2013 (TYP SA, 2012; TYP SA, 2013) in order to get an overview of current reuse practices in Europe. A large part of these reports, however, refers to information sources from 2006-2007. In particular, comprehensive data on quantities reused date back to 2006 (such data was produced as part of the EU-funded AQUAREC project – see Hochstrat et al., 2006).

According to these sources, in 2006 it was estimated that the total volume of reused reclaimed water in the EU amounted to **964 million cubic metres per year (Mm³/year)**, accounting for **2.4% of the treated urban wastewater effluents** (Hochstrat et al., 2006). Figure 2 below presents the amount of reused wastewater in European countries, as estimated by AQUAREC in 2006, relative to the spatial distribution of water stress. **Spain** accounted for about **a third of the total volume of EU water reuse (347 Mm³/year)** while **Italy** used approximately **233 Mm³/year**. In both countries, agriculture is the dominant use. Reclaimed water reuse was also significant in **Cyprus (100% of treated effluents)** and **Malta (just under 60%)**, whereas in Greece, Italy and Spain water reuse constituted only between 5 and 12 % of their treated effluents.

¹⁷ Source: Verbal information from IWA expert

Figure 2: Reuse of reclaimed water in Europe (2006)



Source: Hochstrat et al., 2006

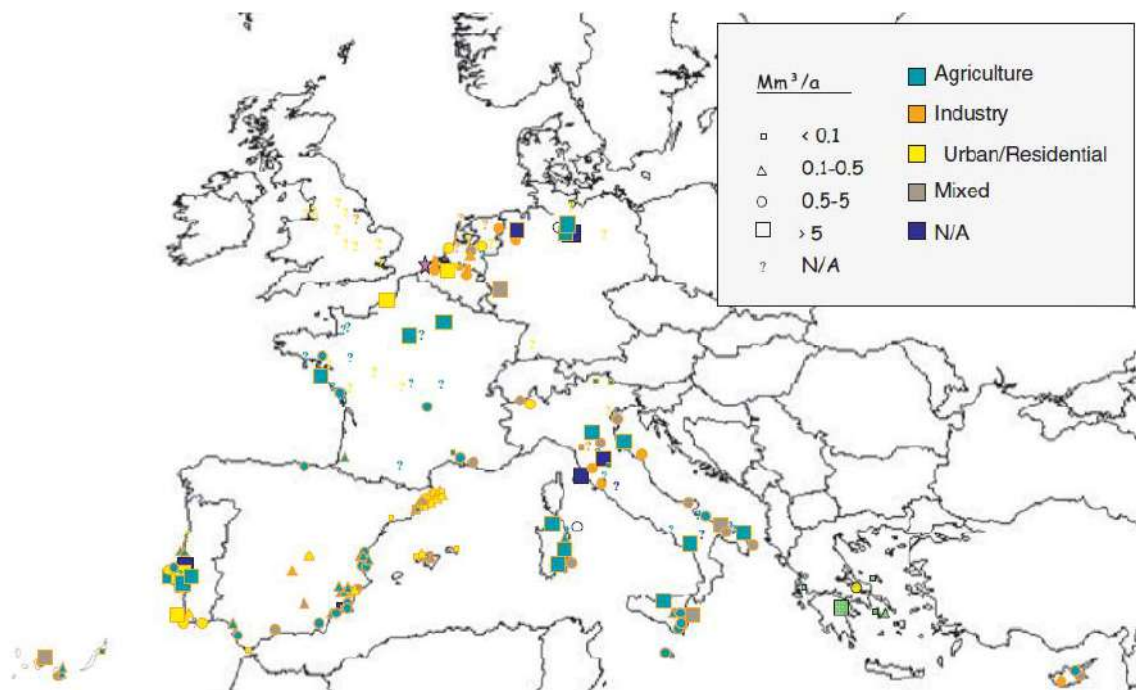
A qualitative overview of the water reuse situation by Member State is provided in the 2013 report by TYP SA for DG ENV; this information is synthesised in the next paragraphs, while further details are provided in Annex A, for each MS.

The literature suggests that some countries have little or no evidence of any water reuse schemes; this is understandably the case in countries with high water availability and low drought risk, such as Ireland or Finland. However, some MS that have experienced severe water stress recently are also in this situation, including some Baltic MS (e.g. Latvia and Lithuania), as well as eastern European MS (Romania, Slovakia, Slovenia, and Hungary). It is important to highlight that the southern and Baltic states usually have efficient urban WWTPs, hence there is potential for reusing reclaimed water. Such potential is much more limited in eastern European states, where effective sewerage networks and WWTPs equipped with secondary treatment technologies are lacking at present.

Member States in which evidence of water reuse has been found include Scandinavian countries (Sweden, Denmark), southern European states (Spain, Cyprus, Malta, Italy, Greece, Portugal) as well as North-Western countries (France, Belgium, UK, Luxembourg, the Netherlands). In Luxembourg, Sweden and Denmark, water reuse is driven by **high water prices** and **ecological concerns**, especially during the summer. For instance, several Danish industries recycle wastewater, while in Sweden wastewater is used for irrigation purposes. Reuse of water for **agricultural** activities is also very widespread in southern European countries, although it must also be highlighted that water reuse in these countries is also driven by **tourism**. In European regions that are not water-scarce but experience episodic drought events, water recycling is becoming much more widespread and being implemented in the agricultural, urban and industrial sectors. This is the case for countries such as the UK and France, where competition for increasingly limited water resources during peak demand periods is driving interest in alternative sources. Even short dry spells in humid or temperate countries can trigger temporary restrictions in freshwater abstraction.

Furthermore, interest in water reuse implementation can be evaluated by considering the number and geographical spread of projects in Europe. Such an analysis was conducted in 2005 during the AQUAREC project (Figure 3).

Figure 3: Identifiable water reuse projects in Europe, incl. their size and intended use (Bixio et al., 2005)



Eurostat data

The information that is publicly available through Eurostat is presented in Table 1 below¹⁸. In the Eurostat statistics, 'reused water' refers to **water that has undergone wastewater treatment and is delivered to a user as reclaimed wastewater (direct supply)**. Wastewater discharged into a watercourse and used again downstream (indirect reuse) is excluded, as is recycling within industrial sites. Planned indirect reuse, such as groundwater recharge, is also excluded from this definition.

Only six MS (Bulgaria, Estonia, Spain, Cyprus, and Malta) provided statistics at least once in the 10-year range reported by Eurostat (2000-2009).

Table 1: Reported volumes of reused water per year (Mm³) between 2000-09 by Member State, for those who provided data to Eurostat

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Bulgaria	-	-	-	-	7	8	10	10	21	6
Estonia	5	6	5	1	8	3	3	3	4	4
Spain	267	305	331	363	393	395	480	501	525	-

¹⁸ Source: <http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database>

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cyprus	-	-	-	-	10	11	13	13	12	11
Malta	2	2	2	2	2	2	1	1	1	1

- : no data provided

The consistency of the Eurostat data with other data provided by national experts was checked as part of the study. The following two abnormalities were identified:

- In **Bulgaria**, the significant decrease between 2008 and 2009 is likely to be due to a change in the scope of the data reported to Eurostat: until 2008, the data probably included internal water recycling in the industry (which is not supposed to be reported to Eurostat).¹⁹
- In **Estonia**, reportedly there has been no water reuse (apart from internal water recycling in the industry) and the reuse of treated urban wastewater is prohibited by the national legislation. So there was probably a mistake in the reported data.²⁰

Furthermore, according to expert view²¹, the values for ES and CY might include some indirect reuse of water, hence they might not be fully comparable with the other reported data.

Data from official MS reporting under the UWWTD

Under the UWWTD, MS are required to report the percentages of treated urban wastewater volumes that are reused in agriculture, for urban uses, in the industry, etc. (not covering internal recycling). Treated wastewater from industrial sources is not covered by this reporting.

The reporting is required by periods of two years (MS can choose for which year they report data) (see Table 2).

Table 2: Percentages of treated urban wastewater that are reused in the Member States, for those who provided data under the UWWTD reporting framework

	2005/2006	2007/2008	2009/2010	2011/2012
BE	2% (Industry)	-	-	-
CY	88% (Agriculture)	95% (Agriculture)	93%	94%
ES	13% (Agriculture)	13% (Agriculture)	93%	-
IT	9% (Agriculture, Industry and others)	(no figure but reuse in Industry and others)	-	(no figure but reuse in Agriculture and Industry)
MT	45% (Agriculture)	-	27%	4,5% ²²
UK	-	18% (Agriculture, Industry and others)	<i>de minimis</i>	<i>de minimis</i>

- : not reported

¹⁹ Source: East Aegean River Basin Directorate, Bulgaria

²⁰ Source: Estonian Environment Ministry

²¹ Verbal information from IWA expert

²² The low percentage is probably due to upgrade works on the WWTPs. The percentage is expected to be much higher for the next years.

The above figures – which were obtained at a late stage of the present study – would need to be double-checked in order to make sure they are fully comparable and accurate. The very high percentage for ES in 2009/2010 is probably a mistake, while the proportion of reuse in the UK seems very high compared with a country like IT. According to UK experts, the high percentage for the UK is probably due to the inclusion of indirect reuse, and would correspond to periods of droughts.

Data obtained from national experts

Estimates of current volumes of reuse could only be obtained from three MS.

In **Spain**, the current level of water reuse is estimated at about 500 Mm³/y²³.

In **Portugal**, the National Strategic Plan (PEAASAR II) set a target of minimum 10 % of treated wastewater reused by 2013, corresponding to 50 Mm³/y, relying on schemes with high potential of reuse including golf courses (Marecos do Monte, 2010). It represents approximately 1% of the country's total annual water withdrawal²⁴. However, this target has not yet been reached: only about 1% of treated wastewater was reused in 2011 (6.1 Mm³) and the situation has not changed significantly since then²⁵. Out of these 6.1 Mm³, around 89% were reused by the water treatment companies (for internal uses) and around 11% were supplied to third parties (ERSAR, 2012).

In **Cyprus**, the current level of water reuse is estimated at about 20 Mm³/y²⁶.

Data used for the baseline scenario of the present study

A first rough estimate of the current volume of reused water in the EU (in 2015) has been proposed at around **1,100 Mm³/y**. This is assuming a slight increase between 2006 and 2015, only driven by ES²⁷.

This volume represents approximately **0.4%** of annual EU freshwater withdrawals²⁸.

This estimate will need to be refined following the modelling work that is being carried out by the JRC.

The following paragraphs provide an overview of the current reuse practices in key application areas.

Key applications – current situation

Agricultural irrigation

Agriculture is the main water user in many EU countries, accounting for around 33 % of total water use (EEA, 2012a). However, this proportion can be much higher in certain regions – for example, in parts of Southern Europe (e.g. Spain), it accounts for up to 80% of all freshwater abstractions, with food crop irrigation being the dominant use (EEA, 2012a). In the arid and

²³ Source: Spanish Environment Ministry

²⁴ Portugal's total water withdrawal amounted to 8,463 Mm³ in 2002, according to the FAO AQUASTAT database

²⁵ Source : Portuguese Environment Ministry

²⁶ Presentation made by Cyprus at the CIS PoM working group meeting of 25/03/14

²⁷ Estimate for 2006: 964 Mm³/y. Increase in ES between 2006 and 2015: from 347 Mm³/y (AQUAREC estimate) to 500 Mm³/y (estimate from Environment Ministry).

²⁸ EU freshwater withdrawals estimated at 237,660 Mm³/year in 2011 (Source: Food and Agriculture Organization, AQUASTAT data. <http://www.indexmundi.com/facts/european-union/annual-freshwater-withdrawals>)

semi-arid areas of Europe (southern France, Greece, Italy, Portugal, Cyprus and Spain) irrigation is an essential component of production, helping to increase yield. In other European countries (central and northern regions), the proportion of water abstracted for crop irrigation is much lower but still significant given increasing and competing demands vs limited water resources. Here, irrigation is primarily used for quality assurance to provide high quality, consistent supplies of produce to retailers and processors (Knox et al., 2012). Most water used in agriculture for irrigation is abstracted from surface or groundwater and used direct with relatively little on-farm storage (reservoirs).

The social and environmental acceptability of using reclaimed water directly for agricultural irrigation varies significantly internationally and between individual EU MS (see Section 2.8.3.3). In general, it is considered to be a potentially high value nutrient source, reducing the need for supplemental applications of mineral fertiliser but equally requiring very careful handling and agronomic management, due, for example, to variable agronomic quality. There are also concerns regarding indirect impact of wastewater on soil ecology.

The largest European water reuse scheme for agricultural irrigation is located near Milan, in Italy, where approximately 86 Mm³/y of reclaimed water is used for irrigation of rice, corn, grass and horticulture. Various other examples of reuse schemes in the agricultural sector are provided in Annex A.

Industrial uses

As a reminder, applications covered by the present study include:

- Reuse of urban treated water by the industry; and
- Reuse of treated water from an industrial plant by another industrial plant or for other purposes such as agricultural irrigation, urban uses, etc.

Internal water recycling is not within the scope of the study.

In Europe, the industry and energy sectors account for 40% of the overall water use. In an industrial context, water can be both part of the product (e.g. in food) and an important element of the processing of materials that result in a product (e.g. as a washing medium or as boiler feed). Despite industrial processes often being complex and quality critical, extensive progress on water reuse in industry has been realised in many industries in the last decades, typically driven by the “Cleaner Production” imperative and the increasing cost of delivered water and of developing new supplies (e.g. boreholes). In Central Europe, water recycling is mainly driven by **cost savings**, while in Western Europe **ecological concerns** also play a part in water saving measures.

The degree of water reuse in industry differs significantly across industrial sectors and is strongly dependent on both the nature of the industrial process and local circumstances.

While the **food and beverage** industries have already made significant progress in internal water recycling, the potential for reusing water from external sources is currently limited due to health concerns related to the use of recycled water in direct contact with food products. Although EU legislation does not impose specific restrictions on the use of recycled water in the food industry (see Section 2.4.2.1), some MS have implemented regulatory standards requiring drinking water quality for water in contact with food (GE Power and Water, 2008). For instance, **Italy** limits the use of recycled water in industry to applications **not involving contact with food (or cosmetics)**. Moreover, national law in **Spain does not allow reuse of water in the food industry** and in any other uses that may entail risks for human health or the environment (food

industry, hospitals, refrigeration towers in most cases, ornamental use). When water reuse in the food industry is allowed, provided it satisfies food safety obligations, a validated and verifiable systematic food safety management tool such as the HACCP system is required. However, most food-processing companies are reluctant to investigate reuse options given the reputational risks that are associated with potential microbial contamination (Seneviratne, 2007).

Water reuse systems in industry are also often associated with lower energy demand. Although the use of treated municipal effluent in industrial processes is not very common in Europe, some high profile schemes have been implemented. For instance:

- In Spain, the Holmen paper mill completely covers its water demand through reclaimed effluent from one of Madrid's municipal WWTP²⁹;
- In the UK, treated urban effluents are used as a feed for power station cooling under the Flag Fen scheme (EUWI-MED, 2007); and
- In Italy, treated wastewater (1.2 to 2 Mm³/y) from the wastewater treatment plant of Baciavallone is fed to the dedicated industrial aqueduct of Prato (Tuscany region), contributing substantially to cover the water needs of industries in this area.

Urban uses

Water reclamation and reuse in urban environments is becoming a major component of urban water security strategies (Rygaard et al., 2011). At present, 37% of wastewater reuse in southern Europe is utilised in urban or environmental applications (Sato et al., 2013).

Treatment of wastewater for urban reuse ranges from none to enhanced use of membranes and chemicals and is delivered for uses as diverse as **domestic toilet flushing** through **fire-fighting** supply to **urban green space irrigation**. Non-potable reuse schemes are widespread in countries such as Japan where thousands of commercial and public buildings benefit from recycled water for toilet flushing. Recent years have also seen a slow but steady increase in **planned indirect potable reuse** applications utilising intermediate natural processes such as infiltration basins, river bank filtration, dune filtration, and **Aquifer Storage and Recovery (ASR)**. The most well established ASR scheme in Europe is at **Torreele in Belgium**, which achieves a 70% saving in abstraction of rainfed water from the supply aquifer (Van Houtte et al., 2008). A useful overview of indirect potable reuse projects can be found in Rodriguez et al. (2009). Direct planned water reuse for potable use (where there is no intermediate storage between the WWTP and the drinking water treatment plant) is not implemented in the EU, but there are a few examples in the USA³⁰ and in Namibia³¹.

Recreational or environmental purposes

In Europe, and especially in Mediterranean areas, reclaimed water can be used for **restoring and enhancing natural habitats** such as wetlands or marshes. Creation of these types of habitats, for environmental and recreational purposes, is also supported by water reuse.

For example, in Catalonia, and especially in the highly touristic Costa Brava area, reclaimed water is primarily used for environmental and recreational uses. For instance, water resources in the *Aiguamolls de l'Empordà* nature reserve (Empuriabrava) are limited, so a reclamation

²⁹ <http://www.aquafit4use.eu/news/when-water-is-a-critical-issue.html>

³⁰ Big Spring scheme operated by the Colorado River Municipal Water District (CRMWD) in Texas

³¹ See in particular the WINGOC scheme: <http://www.wingoc.com.na/process.html>

scheme was developed to restore the manmade Cortalet lagoon and recover the area's former wet meadows (Sala, 2011). The project was based on a constructed wetland system for restoring and/or recreating aquatic ecosystems.

Recycling of water for environmental purposes includes **recharging aquifers** in order to **protect groundwater from saline intrusion**, thus controlling and preventing land subsidence. This technique can also be used to **store reclaimed water in the winter months**, in order to better address the demand during the summer. Given aquifer recharge has many advantages (negligible evaporation, little secondary contamination by animals, no algal blooming and no pipeline construction), it is an interesting alternative to conventional surface water storage. However, the practice of groundwater recharge is **severely frowned up** and, until now, no major agriculture reuse project including a groundwater recharge option for storage has been developed in Europe (WssTP, 2013). There are, however, examples of artificial aquifer recharge projects being set up in Mediterranean countries. In the Barcelona region, a reuse scheme involving the **El Prat de Llobregat** water reclamation plant combines aquifer recharge, wetlands maintenance, agricultural irrigation, the maintenance of the Llobregat River ecological flow as well as urban and industrial applications. Another example of aquifer recharge can be found in **Cyprus**, where treated water recharges the **Ezousas aquifer** through specially constructed shallow ponds³². This water, after natural purification, is pumped again from the aquifer for irrigation. Pumping is carried out strategically so that retention time in the aquifer is maximised.

2.2.2 Future trends

Overall situation

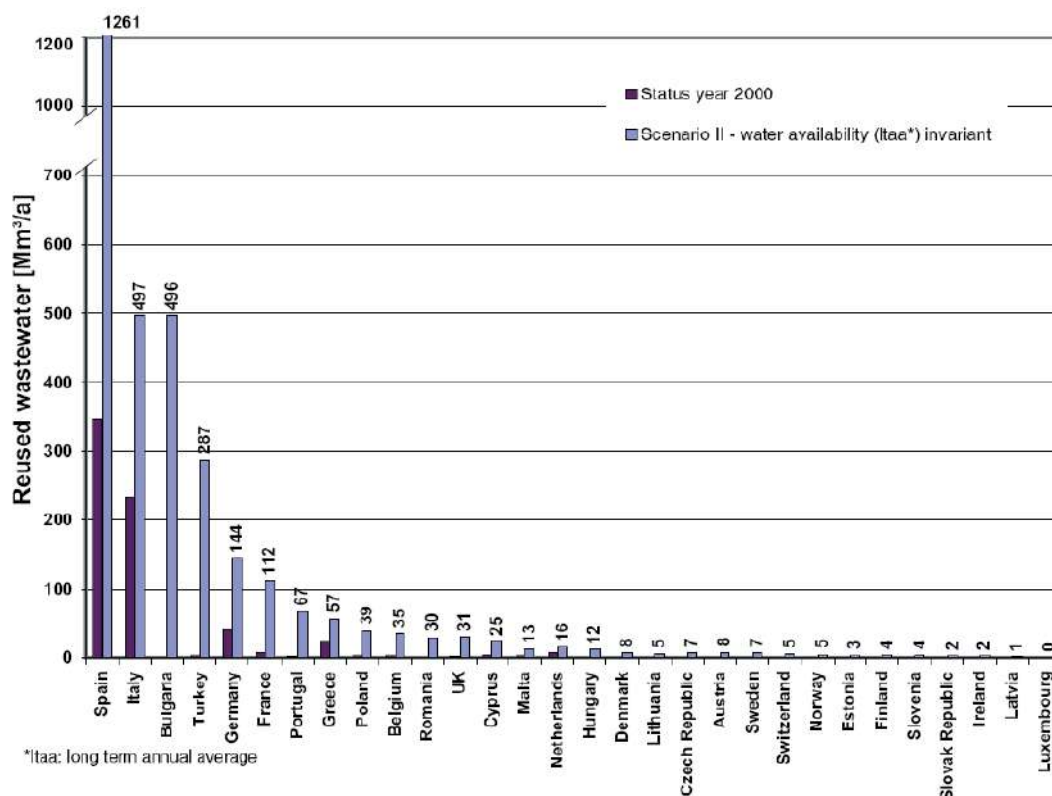
All information sources agree on the **significant potential for further development of water reuse projects in the EU**. **Climate change** pressures are likely to increase the level of interest in such solutions for both mitigating wastewater disposal impacts and episodic drought effects (Falloon et al., 2010). Moreover, a number of countries are developing the political and – for those that do not possess suitable wastewater treatment technology – technical capacities needed to promote the uptake of water reuse solutions.

There are, however, few reliable data on future trends of reuse in the different MS. In the present section, the results of a modelling work carried out in 2006 are presented and put in perspective with more recent estimates obtained from national experts, in order to provide quantitative indications for the baseline scenario.

In 2006, the AQUAREC project developed a model to estimate the potential for water reuse in the EU by 2025. This model was based on a mass balance approach considering the quantity of reclaimed water available for reuse on the one hand, and the demand for such water in different activity sectors on the other hand. Key results from this model are presented in the figure below (see the 'Scenario II' data).

³² Case study: Artificial recharge of the Ezousas aquifer in Cyprus with tertiary treated sewage (provided by the Cyprus Water Department)

Figure 4: Model output for wastewater reuse potential of European countries on a projection horizon of 2025 (Scenario II), from the AQUAREC project



Source: Hochstrat et al., 2006

Overall, the estimate predicts a wastewater reuse volume of **3,222 Mm³/year** in Europe by **2025**, with **Spain showing the greatest reuse potential (over 1,200 Mm³/year)**. **Italy and Bulgaria** both have an estimated reuse potential of approximately **500 Mm³/year**, while **Germany and France** are projected to reuse **142** and **112 Mm³/year** of water respectively; they are followed by **Portugal and Greece**, which account for a reuse potential of **less than 100 Mm³/year**.

The modelling approach used by AQUAREC, however, has several limitations that need to be taken into account:

- The modelling approach does not take into account the socio-economic and technical feasibility of setting up water reuse projects. For instance, the model does not integrate cost considerations and the evolution of local pricing policies. It does not either take into account the influence of factors such as the geographical disparities between offer and demand for reclaimed water³³ or the seasonality of demand for irrigation water³⁴ (these two factors tend to reduce the water reuse potential).
- The available freshwater resources were assumed to be constant in future.

³³ Typically, urbanised coastal areas are served by WWTP but have limited need to reuse water, while water stressed and rural inner lands would benefit from reclaimed water but are too far from WWTPs.

³⁴ For example, data for Portugal shows that, during 3 months of the year (April, May, October), the demand for irrigation water exceeds the available volumes of reclaimed water (Marecos do Monte, 2010)

- The estimates were based on reported capacity of WWTPs. Since most WWTPs operate well below their reported capacity, the actual volume of final effluent could be lower.
- Environmental regulations also often require maintaining environmental flows in surface water bodies, which could limit reuse potential (i.e. preventing final effluent from being diverted away from surface water discharges).
- Results do not account for the potential effects of EU and national policy measures that have been implemented since 2006 or that could be adopted by 2025 in relation to water reuse. Some of these policies may contribute to a higher uptake of water reuse (e.g. awareness raising measures), while others may restrict the water reuse potential (e.g. in the case of national standards that are difficult to implement, as observed in FR and IT).

Furthermore, the AQUAREC results can be put into perspective by comparing them with estimates developed by some national authorities. The only three MS which are known to have estimated their water reuse potential are Cyprus, Portugal and Spain:

- In **Cyprus**, a total volume of **86 Mm³/y** of treated municipal effluents is expected by 2025 (compared to about 20 Mm³/y today), almost all of which is expected to be reused (for irrigation and aquifer recharge)³⁵. This figure is much higher than the potential estimated by AQUAREC for 2025 (25 Mm³/y).
- In **Portugal**, only about 1% of treated wastewater was reused in 2011 (**6.1 Mm³**) and the situation has not changed significantly since then³⁶. A new water reuse target might be set in the forthcoming national strategic plan (PENSAAR 2020). According to national stakeholders, under a business as usual scenario the **situation is not expected to change significantly** in the near future, due to a number of obstacles (lack of economic incentives, insufficient public awareness and acceptance, high administrative burden to obtain permits, etc.).
- In **Spain**, it is expected that water reuse could increase from around 500 Mm³/y (current situation) up to around 700 Mm³/y (without further policy intervention), and could reach a maximum level of approximately **1,200 Mm³/y by 2018** if more awareness raising and information-related initiatives were put in place by the government³⁷. The target of 1,200 Mm³/y by 2018 is included in the National Water Reuse Plan. It is similar to the potential estimated by AQUAREC for 2025. It represents approximately 4% of the country's total annual water withdrawal³⁸.

In **France, Italy and Greece**, according to national experts **no significant increase in water reuse is expected** in the future due to the high administrative burden and complexity associated with the application of the standards, which creates strong disincentives to the development of new schemes (this is further explained in Section 2.6). In addition, in Greece,

³⁵ Presentation made by Cyprus at the CIS PoM working group meeting of 25/03/14

³⁶ Source : Portuguese Environment Ministry

³⁷ Source: Spanish Environment Ministry

³⁸ Spain's total water withdrawal amounted to 32,460 Mm³ in 2008, according to the FAO AQUASTAT database

preliminary information from experts indicates that the AQUAREC estimate for 2025 (57 Mm³/y) may be difficult to achieve in a cost-effective way³⁹.

In **Bulgaria**, the high potential for 2025 estimated by AQUAREC (496 Mm³/y) seems very optimistic considering that the current level of reuse is very low. According to national experts, there is **no significant increase of reuse expected** in the near future, because the treatment processes in urban WWTPs are not yet sufficient to produce reclaimed water of the required quality. Furthermore, Bulgaria is among the MS with the lowest compliance rates with regard to the UWWTD's wastewater collection requirements (below 30% in 2009/2010) (EC, 2013b).

Further details on the possible future trends in each MS are provided in Annex A.

Data used for the baseline scenario of the present study

Recently collected data shows that water reuse is **not expected to increase significantly over the next 10 years**, if no further EU policy actions to promote such practices are implemented.

A first rough estimate of the total EU water reuse volume **in 2025** was developed for the purposes of this study: under a Business As Usual (BAU) scenario, a volume of around **1,700 Mm³/y** could be reached (i.e. total volume of reclaimed water that would be reused in 2025 in the absence of further EU policy actions to promote such practices). This is based on the following assumptions:

- Achievement of the water reuse target in ES (1,200 Mm³/year expected by 2018 with further policy intervention at national level, vs approx. 500 Mm³/year today); and
- No increases in reuse in other MS (compared with the current status).

This estimate will need to be refined following the modelling work that is being carried out by the JRC.

Key applications – Future trends

Agricultural irrigation

Over the next few decades, changes in climate - including greater rainfall uncertainty - are projected to have major impacts on the demand for irrigation water, not only in humid or temperate environments (see for example Daccache et al., 2011), but also in arid regions (see for example Rodriguez et al., 2007(b)). Water reliability during peak summer periods for irrigation abstraction is likely to become a key constraint on production. In this context, finding affordable ways to support agricultural irrigation will become more important in Europe. Population growth and changes in dietary food demands will further drive up demand for irrigated produce. An increasing demand for water, including recycled water where fresh water is not available, is therefore expected in the future.

³⁹ Source: verbal information from the University of Crete. Effluent from Athens's WWTP, serving approximately 35% the country's population, is most likely not economically feasible due to the location of the plant (the small island of Psitalia). The possible transportation of 20,000 m³/day of treated effluent from the island back to the city areas for landscape irrigation and industrial use, at an estimated cost of 0.40 EUR/m³, was shown to be not cost effective, at least for the time being.

Industrial uses

Although individual installations have important water reuse potential in Europe, there are additional areas where water reuse could be further improved such as inter-business water cascading in industrial parks and conjoint reuse of municipal effluent with urban or agricultural applications. Although the drivers for industrial reuse schemes have traditionally been characterised as financial in nature, recent projects have been equally influenced by concerns over **security of supply** and **independence from public supply networks** (which often has advantages for water suppliers as well).

The potential for increasing water reuse will differ significantly across industrial sectors. For example, in the food industry where water reuse is generally less accepted (due to food safety concerns), the main driver would be the possibility to obtain **water of higher quality in a reliable manner**. In **Denmark**, where the food industry is a key economic sector, there is an increasing interest in investigating possibilities for **using water of another quality than drinking water**, so that the high quality groundwater is reserved for drinking water purposes; guidelines on water reuse are being developed to support this objective⁴⁰.

Urban uses

A report issued by Global Water Intelligence in 2010 (GWI, 2010a) suggests that high value urban water reuse schemes will see the strongest market growth over the coming years. It draws attention to recent schemes in India and Mexico where the impetus for water reuse is driven by urban infrastructure investment programs in cities with fragile water resource availability. However, water reuse for urban uses, and in particular for potable supply (whether direct or indirect), is likely to continue to be a contentious issue requiring close attention from politicians, water managers and scientists over the coming years. Recent years have seen significant progress in developing sound technical approaches to the production of high quality and reliable water sources from reclaimed wastewater. Although there are **significant public perception issues** to be tackled if potable reuse is to become the norm, such schemes offer increased and economically efficient water availability and reliability without the need for secondary (and costly) distribution and storage systems (Leverenz et al., 2011).

There is significant potential for the further development of urban water reuse in the EU, considering the number of successful projects at the international level. Several EU and non-EU projects such as Belgium's Torrelle scheme, Singapore's NEWater programme, the Orange County Groundwater Replenishment scheme in California, and the Western Corridor project in Australia, provide excellent examples of successful urban reuse schemes (indirect reuse for drinking water production). The treatment involves the use of a three-stage advanced wastewater treatment process (microfiltration/ultrafiltration, reverse osmosis and advanced oxidation) to create product water far beyond normal tap water quality. The delivered water is planned to be sold to high-value industrial customers, injected into aquifers for storage, or blended in reservoirs for indirect potable reuse. Such schemes are transforming the urban water reuse market towards high value / high reliability applications.

⁴⁰ Source: Danish Environment Ministry

2.3 Potential for increasing water reuse

Numerous publications have stressed the significant potential for increasing water reuse in the EU and have underlined the contribution it could make to address water scarcity; however, none of these publications has quantified the optimal level of reuse that could be achieved in the EU in the case of stronger policy incentives.

Quantifying the potential for increasing water reuse at the EU level is difficult, because water reuse is a **local solution**: the **maximum level** of reuse that could be achieved in a **cost-effective** way is very much dependent on **local specificities** such as the distance between offer and demand (e.g. between WWTPs and users) and the socio-economic context.

A very rough estimate of the water reuse rate that might be achieved in the case of stronger regulatory and financial incentives at the EU level has been developed for the purposes of this study. This estimate assumes that five of the MS with the highest reuse potential according to the AQUAREC model (IT, DE, FR, PT and EL) could reach the same water reuse rate as ES by 2025, expressed as a percentage of their total annual water withdrawal⁴¹. If these five MS had a water reuse rate equivalent to **4% of their total annual water withdrawals**, with the situation remaining similar to the baseline scenario for 2025 in the other MS, this would give an overall EU water reuse potential of the order of **6,000 Mm³/y by 2025**⁴².

Although this rough estimate does not take into the differences in terms of geographical, socio-economic and policy context between Spain and the other five MS considered (and thus disregards the cost-effectiveness of the further development of water reuse), it could be considered as a feasible long-term estimate given that:

- The availability of freshwater resources in those MS is likely to decrease in the future, due to the impacts of climate change (EEA, 2009);
- A water reuse rate representing 4% of total annual water withdrawal is still far below the levels encountered in non-EU regions such as certain Australian states or Singapore (15-35 % of water demand met by reclaimed water in these areas) or the water reuse target set in Catalonia (covering approximately 30% of freshwater needs);
- The assumption that no further increases in water reuse would occur in the other MS, in comparison with the baseline scenario, is relatively conservative.

Another way to estimate the EU water reuse potential could be based on the volumes of treated urban wastewater available for reuse in each MS, by assuming that a certain percentage of this could be reused. The Catalan water reuse target could be used as an example for such a calculation: in this region, the target was set at 30% of the treated urban wastewater, following a detailed analysis of cost-effective reuse opportunities within a certain perimeter around the WWTPs. Data on the volumes of treated urban wastewater are, however, not available for all MS (only compliance rates with regard to the different requirements of the UWWTD are currently available).

⁴¹ BG was identified by AQUAREC as having a high potential for reuse, however there are strong limitations in terms of reclaimed water supply in this country, hence it is excluded from our estimate

⁴² Total annual water withdrawal data taken from the FAO AQUASTAT database

2.4 Policy context

This section provides a description of the policy context in relation to water reuse. This policy context is described at the international, EU and Member State levels. This section also presents a comparison of some existing water reuse standards.

Current and likely future effects of the policy measures described in this section are considered to be part of the baseline scenario.

2.4.1 International policy context

2.4.1.1 International standards

WHO guidelines for the safe use of wastewater

Guidelines for the safe use of wastewater, excreta and greywater, published by the World Health Organisation (WHO), are a key reference for any country wishing to manage health risks associated with water reuse in agriculture and aquaculture, and to develop a policy framework aiming to minimise such risks.

The first version of the WHO guidelines was issued in 1973, a second version was issued in 1989 and a third version in 2006.

The WHO guidelines are designed to protect the health of farmers (and their families), local communities and product consumers. They are meant to be adapted to take into consideration national socio-cultural, economic and environmental factors. The approach is intended to support the establishment of national standards and regulations that can be readily implemented and enforced. Such standards or regulations should adopt the format of a safe wastewater reuse plan, in line with the concept of water safety plans in other areas of water quality management and health protection and promotion.

According to expert view⁴³, the WHO guidelines are mainly used in developing countries and their implementation is facing some challenges. In particular, developing countries have difficulties to use the very technical information provided by the guidelines and to adapt it in order to develop suitable national standards. There is no information currently available to assess whether the implementation of the WHO guidelines has had a significant effect on the level of uptake of water reuse solutions in specific countries.

The WHO guidelines are also a key reference for the food industry. According to Copa Cogeca, many food retailers require their suppliers to comply with the WHO guidelines on water reuse.

A **revision process of the WHO guidelines** started in 2014, with a first meeting in June 2014. The current ambition is to publish a revised version of the series of technical documents, along with implementation-oriented documents. In addition, the WHO plans to develop specific water reuse guidelines for potable water production purposes; these guidelines would include limit values for chemicals, while the existing guidelines mainly cover microbiological parameters. It is also planned to provide a more straightforward presentation of technical aspects such as health-based targets. The revision process is expected to include the following steps:

⁴³ Verbal information from Mr Fawell, expert working for the WHO

- **By 2015:** Technical report summarising the evidence basis with regard to all types of applications concerned.
- **In 2015-2017:** Interim publications covering the different applications (urban reuse, updates on agriculture/aquaculture, indirect potable reuse, greywater reuse in buildings).
- **2019:** Publication of the final guidelines, including a common chapter on safety planning and other general aspects, and separate chapters covering the different applications. These will include guideline values, where appropriate, for the different types of applications.

Further details on the WHO guidelines are provided in Annex B (Comparison of water reuse standards).

ISO standards

ISO standards on the reuse of reclaimed water are under development, following a request from Japan, China and Israel⁴⁴ (ISO/TC 282 committee on Water re-use⁴⁵). The ongoing work concerns the **standardisation of water re-use of any kind and for any purpose**. It covers both centralised and decentralised or on-site water re-uses, direct and indirect ones as well as intentional and unintentional ones. It includes technical, economic, environmental and societal aspects of water re-use. Japan and China hold the secretariat and of the 19 participating countries, seven are from the EU. Further details can be found in the ISO Technical Management Board Resolution 19/2013⁴⁶. A first meeting was held in January 2014.

The draft strategic business plan⁴⁷ (Dec 2013) specifies the main objectives and priorities in the work of the committee, i.e.: the definition of a terminology common to the different stakeholders; specification of the elements to be considered for planning, designing, operation, monitoring and maintenance of water re-use including for various applications (irrigation, urban, environmental and industrial uses); and methods and indicators for risk and performance evaluation of water re-use systems.

With regard to irrigation uses, work is underway to develop the **ISO 16075 series 'Guidelines for Treated Wastewater Use for Irrigation Projects'**⁴⁸, with a targeted publication date in **2015**. These guidelines aim to prevent any adverse impacts on public health, the environment, soils and crops, as a result of irrigation with reclaimed water. The following first draft documents have been developed to date:

- Part 1: The Basis of a Reuse Project for Irrigation – Includes in particular guidelines on maximum recommended levels of nutrients and salts in reclaimed water and on treatment levels to abate phosphorus, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and heavy metals;

⁴⁴ http://www.iisc.go.jp/international/nwip/tsp236_Water%20re-use.pdf

⁴⁵ http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=4856734

⁴⁶ http://www.iisc.go.jp/international/nwip/tsp236_Water%20re-use.pdf

⁴⁷ http://www.aspe.org/sites/default/files/webfm/pdfs/N19_Draft_Strategic_Business_Plan_TC282_.pdf

⁴⁸ http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=616869

- Part 2: Development of the project – Includes in particular guidelines on limit values associated with different water quality levels, quality levels for different use types, setback distances, etc.;
- Part 3: Components of a reuse project for irrigation – Includes in particular design specifications for the treatment, storage, distribution and irrigation infrastructure; and
- Part 4: Monitoring.

Another specific committee was created in 2014 to develop standards on **water reuse in urban areas**⁴⁹.

At the EU level, the European Committee for Standardization (CEN) has started discussions on the possible need for CEN standards on water reuse, taking into consideration the work carried out by the ISO. It should be noted, however, that it is not possible for the CEN to develop new EU standards if ISO standards with the same scope have already been developed⁵⁰.

2.4.1.2 Policy measures in non-EU countries

A significant number of countries have developed a **legislative framework and/or guidelines for the safe use of treated wastewater**, in order to minimise health and environmental risks associated with water reuse practices. While the WHO guidelines only refer to the safe use of reclaimed water in agriculture and aquaculture, other well-known guidelines such as the USEPA or Australian guidelines consider several other applications like aquifer recharge, irrigation or recreational uses. A comparison of water reuse standards developed by EU and non-EU countries is presented in Annex B, and summarised in Section 2.4.3.1 below.

Other types of policy measures implemented in non-EU countries include **price incentives**, **awareness-raising** measures and **water reuse targets**. A few examples are presented in Table 3 below and further details are available in Annex C (covering Australia, Israel, Jordan, Singapore, USA, and California). It can be noted that many of these countries have implemented a combination of the above-mentioned policy measures in order to promote water reuse.

⁴⁹

http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?cmmid=5261836

⁵⁰ This rule is defined by the 'Agreement on technical co-operation between ISO and CEN' (Vienna Agreement). Essentially, the agreement recognises the primacy of international standards, but it also recognises that particular needs (of the Single European Market for example) might require the development of standards for which a need has not been recognised at the international level.

Table 3: Examples of policy measures to promote water reuse (other than standards) implemented in non-EU countries

Policy measures	Examples
Price incentives	Israel: Water reuse for agriculture is highly subsidised. The State fully pays for the conveyance and storage of water and also takes over the cost for upgrading wastewater to a high quality level. The users (farmers) are only charged the cost for 'low level treatment' suitable for restricted irrigation. This subsidisation is less costly than treating wastewater to a quality suitable for discharge into surface waters (Fine et al., 2006). Australia: Some schemes with the aim to avoid or reduce effluent discharge into sensitive aquatic environments do not charge at all treated wastewater if for reuse purposes (WSAA, 2005).
Awareness raising measures	Singapore: The NEWater project was accompanied by an impressive public awareness program to build a national commitment to water reuse. A Visitor's Centre was built to convey information on the project. USA: The National Water Reuse Database (NWRD) provides utility/facility general information and annual data on the flow, treatment, and end use of recycled water from the states reusing the most water: California, Florida and Texas. It aims to encourage, improve and disseminate information regarding the practice of water reuse, in order to advance the practice and implementation of water reuse at the local, regional, state and national level.
Water reuse targets	Australia: In 2007, the government itself committed to a national target of recycling 30% of wastewater by 2015. In addition, many major cities and several states have set targets to achieve specific percentages of wastewater recycling. California: Target to increase the use of recycled water over 2002 levels by at least one million acre-feet per year (afy) (~ 1,233 Mm³/y) by 2020 and by at least two million afy (~2,467 Mm³/y) by 2030 Singapore: For non-potable uses, the target for 2011 (now achieved) was to cover to 30% of Singapore's water needs with the so-called 'NEWater'. Jordan: The government intends to increase reuse of treated domestic wastewater in agriculture to 220 Mm³ by 2022, which then would constitute 13% of the available water resources.

2.4.2 EU policy context

The reuse of **treated urban wastewater** is not regulated as such by EU legislation, although some of its applications (e.g. groundwater recharge, potable water production) are subject to clear legal requirements.

With regard to the reuse of **industrial wastewater**, certain types of applications are covered by EU legislation, especially via the enforcement of the **Industrial Emissions Directive (2010/75/EU)** and the associated **Best Available Techniques Reference documents (BREFs)**⁵¹. However, the applications covered mainly concern the internal recycling of process or waste water, e.g. for cooling or washing purposes, which are outside the scope of this study. The recycling of industrial water for external uses is rarely covered by operating permits under the IED and there are no EU legal provisions specifically covering these types of practices (existing legislation refers to the protection of the receiving environment).

While standards have been defined by the WHO and by a number of EU and non-EU countries, at the EU level there are **no common standards for water reuse**. Reuse practices, however, are **promoted by several pieces of EU legislation**. On the one hand, EU environmental legislation refers directly or indirectly to the benefits of water reuse as an alternative supply of fresh water for a number of applications where potable quality is not required. On the other hand, water reuse **has to be carried out under certain conditions** in order to comply with the

⁵¹ For further details on the relevant provisions of the IED, please see Annex D

various environmental and health-related requirements imposed by EU legislation, depending on the type of application concerned. An overview of such legislation is provided in Section 2.4.2.1 below.

Besides this legislative framework and the Blueprint (see Chapter 1), there are several recent and ongoing EU policy initiatives concerning water reuse, as described below.

European Innovation Partnership on Water (EIP Water)

To unlock the full potential of the EU water sector, a **European Innovation Partnership on Water (EIP Water)** was set up⁵². Water reuse is one of the five top priorities of this partnership. The EIP Water aims at removing barriers to innovation, connecting supply and demand for water-related innovations, creating dissemination strategies for proven solutions and supporting market acceleration of innovations. The Steering Group of the EIP Water has invited the Action Groups to develop and test the following solutions⁵³:

- 'Fit for Purpose/Symbiotic approaches based on technical, economic, social and environmental criteria, where cost-effective treatment meets intended use and quality.
- Innovative solutions and/or treatment options, producing and testing recycled/reclaimed water for residential, urban, industrial and agricultural uses, with consideration of ecosystems and involving multiple stakeholders.
- Systems capable of determining the quality of recycled and reclaimed water to improve management and public acceptance according to health requirements.
- Innovative separation- and extraction technology pilot projects in industrial zones to harvest resources from waste- and re-used water'.

Within the EIP Water, the **'WIRE Action Group'** (Water & Irrigated agriculture Resilient Europe) has identified water reuse in irrigation as one of its three priorities⁵⁴. WIRE started its activities in May 2014 and gathers 48 partners. It aims to 'customise existing or upcoming innovation to the farmers' and growers' needs, and to facilitate innovation uptake in the complex, multi-faceted irrigated agriculture reality and market'.

EU-funded research projects

The vital importance of wastewater reclamation and reuse of municipal wastewater for water management in the EU has been acknowledged by the Commission through its General Directorate Research through support of a comprehensive set of **research projects** in the past and current Framework Programmes on Community activities in the field of research, technological development and demonstration. Various issues including water reuse technology, water quality and integrated water management aspects, were addressed in the research projects⁵⁵. Three examples of EU-funded projects are presented in Box 2 below.

⁵² COM(2012) 216

⁵³ <http://www.eip-water.eu/priorities/water-reuse-and-recycling>

⁵⁴ <http://www.eip-water.eu/working-groups/wire-water-irrigated-agriculture-resilient-europe-ag112>

⁵⁵ An overview of key EU-funded research projects is provided in the 2013 report by TYPASA 'Updated report on wastewater reuse in the EU'

AQUAREC project (2002-2006) on 'Integrated Concepts for Reuse of Upgraded Wastewater' (http://cordis.europa.eu/projects/rcn/69076_en.html)

This project aimed to provide knowledge to support rational strategies for municipal wastewater reclamation and reuse as a major component of sustainable water management practices. It produced several deliverables of relevance for policy makers and reuse project developers, including:

A 'Guideline for quality standards for water reuse in Europe' with proposed limits for reclaimed water reuse (Chapter 4 of the document);

A 'Water Reuse System Management Manual' including proposed water quality criteria for different end-uses (agriculture, urban uses, industrial uses and groundwater recharge);

A 'Handbook on Feasibility Studies for Water Reuse Systems', primarily intended for reuse project developers; and

A guideline on 'Participative Planning for Water Reuse Projects', dealing with public acceptance issues.

SAFIR project (2006-2010) on 'Safe and high quality food production using low quality waters and improved irrigation systems and management' (<http://www.safir4eu.org/>).

This project addressed two problems that have become public concerns: the first is the safety and quality of our food products, and the second the increasing competition for clean fresh water around the globe. One of the objectives was to test new technology for water recycling and use in agriculture in southern Europe and other areas with insufficient potable drinking water. The project assessed the impact of the new technology on product quality and safety, production system, and the environment as well as risks from farm to fork.

DEMOWARE project (2014-2016) on Innovation Demonstration for a Competitive and Innovative European Water Reuse Sector' (<http://demoware.eu/en>)

This project will execute 'a highly collaborative programme of demonstration and exploitation, using nine existing and one greenfield site to stimulate innovation and improve cohesion within the evolving European water reuse sector'. The project is guided by SME & industry priorities and has two central ambitions: to enhance the availability and reliability of innovative water reuse solutions, and to create a unified professional identity for the European Water Reuse sector. The project ultimately aims to improve both operator and public confidence in reuse schemes.

EU Structural and Investment Funds (ESIF)

Furthermore, a large number of large-scale water reuse schemes have been developed with the financial support of **Cohesion Policy Funds** as well as the **European Agricultural Fund for Rural Development (EAFRD)** and the **European Maritime and Fisheries Fund (EMFF)**, which have been available for water resource protection measures, in particular wastewater treatment or recycling plants. The planned Cohesion Policy spending on water/waste water for 2007-2013 was EUR 22 billion (IEEP, 2012). The distribution of these funds for the 2014-20 period is being decided at the time of writing this report. Water management remains an important area covered by the funding programmes of the MS⁵⁶. In particular, the Thematic

⁵⁶ For example, in Cyprus, within the Partnership Agreement for 2014-2020, the Water Development Department aims to use EU funds to undertake two treated waste water related projects with a total cost of EUR 28.75m. In Malta, the development of dedicated irrigation water distribution networks will be part-funded under the European Agricultural Fund for Rural Development (EAFRD).

Guidance Fiche for Desk Officers states that ‘water reuse should become one of the key priorities for investments in the water sector’⁵⁷.

Finally, the reuse of water is one of the aspects considered in the development of **Green Public Procurement criteria for waste water infrastructure** (EC, 2013a).

2.4.2.1 EU legislative framework

The following is an overview of current EU legislation that refers to water reuse and/or contains specific provisions that need to be taken into account when reusing wastewater for specific purposes.

Water Framework Directive and its daughter Directives

The global legal framework defined through the **Water Framework Directive (WFD)** (2000/60/EC)⁵⁸ aims to guarantee sufficient quantities of good quality water across Europe as needed for the different water uses, and environmental quality of this water. Key aims of the WFD that are particularly relevant to the present assessment include: to achieve ‘good status’ for all waters by 2015; to base water management on river basins; to combine emission limit values with environmental quality standards; to ensure that water prices provide adequate incentives to use water resources efficiently; and to involve citizens more closely.

In the WFD, the use of reclaimed water is considered **as a means of increasing water availability** which may contribute to the **good quality status** of water resources; it should therefore be considered as **an option in the ‘programmes of measures’** to be established when implementing the WFD. The Directive refers, under Annex VI (v), to ‘emission controls’ and, under Annex VI(x), to ‘**efficiency and reuse measures, inter alia, promotion of water efficient technologies in industry and water saving techniques for irrigation**’ to help achieve good environmental status of water bodies.

Some of the mandatory steps of the WFD are very favourable to strategic reuse planning, in particular the **analysis required by Art. 5** of the WFD (analysis on the characteristics of the river basin district and the review of the environmental impact of human activities as well as the economic analysis of water use): this analysis constitutes a well-grounded basis for identifying where reclaimed water reuse can be a useful option to be considered in the programmes of measures to achieve the environmental objectives, without compromising further economic development. Principles like **cost recovery in water pricing** (Art. 9) and **public participation in water management decisions** (Art. 12) as set out in the WFD have also been identified as essential for a successful, long-term reclaimed water reuse practice.

In the WFD, there is no explicit limitation to use a specific type of water; the only requirement concerns the achievement of quality standards defined in the legislation (either in the WFD itself or in other related Directives). The latest assessment results on the implementation of the WFD and the River Basin Management Plans (RBMPs) have informed the development of the Blueprint.

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http://ec.europa.eu/regional_policy/sources/docgener/informat/2014/guidance_2_thematic_objective_6_water_management.pdf

58 Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF>

In addition to this global framework, there are **several EU water-related Directives establishing specific quality standards** for defined uses or defined environmental receptors:

- the Drinking Water Directive (80/778/EC revised with 98/83/EC)⁵⁹;
- the Bathing Water Directive (2006/7/EC)⁶⁰;
- the Groundwater Directive (2006/118/EC)⁶¹;
- the Environmental Quality Standards Directive (Directive 2008/105/EC)⁶²; and
- the Nitrate Directive (91/676/EEC)⁶³.

Further details on the relevant provisions of these water-related Directives are provided in Annex D. This annex also covers the **Sewage Sludge Directive** (86/278/EEC)⁶⁴, the provisions of which may have to be taken into account when reclaimed water is reused in agriculture (e.g. with regard to cumulated loads of hazardous substances brought to the soil by sewage sludge and reclaimed water, or with regard to the links that can be established between the quality of reclaimed water and the quality of sewage sludge produced by the same WWTP).

In addition, for **groundwater recharge applications**, a **permit is needed under the WFD**; an **Environmental Impact Assessment (EIA)** may be also required, depending on the size of the project (see Annex D for further details on the relevant provisions of the EIA Directive).

In conclusion, for applications other than drinking water, bathing waters and groundwater recharge (agricultural uses, urban uses, golf courses, etc.), there are no EU standards defining the minimum acceptable quality of the supply water.

Urban Waste Water Treatment Directive

Following the WFD and its daughter directives, the second main piece of legislation is the **Urban Wastewater Treatment Directive** (UWWTD) (91/271/EEC amended by 98/15/EEC)⁶⁵. The Directive concerns the collection, treatment and discharge of urban wastewater and the treatment and discharge of wastewater from certain industrial sectors. Its main objective is to protect the environment from the adverse effects of these discharges. It establishes limits for concentration (or percentages of reduction) for some pollutants in the discharged effluent (as a function of the size of agglomerations and sensitivity of the receiving waters).

According to Art. 12 of the UWWTD, **‘treated wastewater shall be reused whenever appropriate’**. The term ‘appropriate’ means that reusing treated wastewater is possible as far as it is not forbidden or restricted by any other EU legislation, does not compromise the implementation of international commitments or does not affect the achievement of the objectives set up in other EU legislation, not only environmental. Flexibility is left to MS, who can make their decisions on a case-by-case basis.

⁵⁹ Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

⁶⁰ Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

⁶¹ Directive 2006/118/EC on the protection of groundwater against pollution and deterioration

⁶² Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

⁶³ Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources

⁶⁴ Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture

⁶⁵ Council Directive 91/271/EEC concerning urban waste-water treatment

The potential for treated water reuse in the EU is directly linked with the **level of implementation of the UWWTD**. Efficient and reliable secondary treatment of urban effluents, as required by the UWWTD, is a minimum condition for the subsequent reuse of water – which, in many cases, will also be subject to tertiary treatment.

The deadlines by which the treatment services must be provided, as well as the level of this treatment, depend on the size of the agglomerations and the sensitivity of the recipient waters. For the fifteen MS which joined the EU before 2004 (EU-15)⁶⁶ these deadlines were 1998, 2000 and 2005. For the thirteen MS which joined the EU in 2004, 2007 and 2013 (EU 13)⁶⁷, deadlines are staged until 2015 (except until 2018 for Romania and 2023 for Croatia). The latest information on the implementation level of the UWWTD can be found in the 7th report on the implementation of the UWWTD (EC, 2013b). Some key findings of this report are presented in Box 3 below.

*Box 3: Key findings on the implementation of the UWWTD Directive (EC, 2013b)*⁶⁸

To date, implementation of the Directive has been challenging mainly because of the financial and planning aspects related to major infrastructure investment such as sewerage systems and treatment facilities.

Collection systems

Most of the EU MS collect their waste waters at very high levels with an average rate of compliance equal to 94% (up from 92%). Fifteen MS⁶⁹ even reach compliance of 100%. All MS have either maintained or improved on previous results. However, there are still countries where there is either no or only partial collection of sewage. Five MS still had compliance rates below 30% in 2009/2010 (BG, CY, EE, LV, SI).

Secondary treatment

In 2009/2010, a total of 82% of the waste waters in the EU received secondary treatment complying with the provisions of the Directive, four percentage points up from the previous report. Four MS reached 100% compliance and another six MS had levels of compliance of 97% and higher. However, the compliance rates in EU-12 MS are trailing behind significantly with only 39% of their waste waters receiving appropriate secondary treatment. Only CZ, HU, LT and SK achieved compliance results between 80-100%.

Outlook

With continued efforts over the coming years, it is possible to (largely) complete implementation successfully in the EU-15 by 2015 or 2016. This would be 10 years after the expiry of the last deadline in the original Directive. The picture is different for those MS which have joined the EU in 2004 and later. Their distance to target is still considerable with average compliance of 72% for collecting systems and 39% and 14% respectively for secondary and more advanced treatment. Without increasing efforts at all levels, expected delays can be similar or longer than those for EU-15 which would bring the laggards in compliance with the Directive as late as 2028.

⁶⁶ Austria, Belgium, Denmark, Germany, France, Finland, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, The Netherlands and United Kingdom

⁶⁷ Croatia, Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria and Romania

⁶⁸ The compliance assessment was carried out for 26 MS given that for Romania, none of the compliance deadlines agreed in their Accession Treaty had expired by 2010. Croatia joined the EU on 1st July 2013 and therefore was not included in this reporting exercise.

⁶⁹ MT, IE, CZ, SK, LU, HU, UK, LT, SE, DK, FI, EL, AT, DE, NL

The above information suggests that, for those MS having joined the EU since 2004, **a significant increase in the volume of treated effluents is expected over the next 10 years**, as a result of the progressive (delayed) implementation of the UWWT Directive. In theory, this will increase the quantities of reclaimed water available for reuse applications. In addition, as **many new WWTPs** are being built or will be built in the near future to comply with the UWWT Directive, this will offer **significant opportunities to take into account possible reuse applications at the design stage**, so that integrated and well-designed solutions could be offered at competitive costs.

Fertiliser Regulation

The Fertiliser Regulation (No 2003/2003)⁷⁰ was introduced to ensure the free circulation on the Internal Market of 'EC Fertilisers' i.e. those fertilisers that meet the requirements of the legislation in terms of nutrient content, safety, and absence of adverse effects on the environment. The Commission intends to revise Regulation (EC) No 2003/2003 and to extend its scope. The risk of contamination by heavy metals is one aspect being considered as part of the review process. Provisions concerning maximum levels of heavy metals may be included in a future revision of the Regulation.

While this Regulation does not directly affect the reuse of reclaimed water, it will be important to ensure that any future EU legislation on water reuse is consistent with its provisions as regards the **total load of nutrients** brought to the soil by both fertilisers and reclaimed water and – possibly – the maximum acceptable quantities of **heavy metals** added to soil (traces of heavy metals may be present in fertilisers, in reclaimed water and in sewage sludge).

Food safety legislation

Several pieces of the food safety legislation are relevant to the safety of agricultural products irrigated with wastewater. This is notably the case of **Commission Regulation (EC) No. 1881/2006 setting maximum levels for certain contaminants in foodstuffs**,⁷¹ with the purpose of keeping them at toxicologically acceptable levels. The Annex to this Regulation lists those foodstuffs to which it applies as well as the maximum level allowed. These include agricultural products (whether they are irrigated or not with wastewater). Failure to comply with those maximum levels means that the foodstuff cannot be placed on the market (Article 1). Parameters include, depending on the foodstuffs, maximum levels for: nitrates; mycotoxins; metals (incl. lead, cadmium, mercury); 3-MCPD; dioxins and PCBs; and polycyclic aromatic hydrocarbons.

Maximum residue limits (MRLs) are also set for pesticides for all food and animal feed, through **Regulation (EC) No. 396/2005**.⁷² This Regulation applies to products of plant and animal origin or parts thereof covered by Annex I to be used as fresh, processed and/or composite food or feed (Article 1); these include: fruit (fresh or frozen), nuts; vegetables (fresh

⁷⁰ Regulation (EC) No 2003/2003 of 13 October 2003 relating to fertilisers

⁷¹ Commission Regulation (EC) No. 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs, OJ L 364, 20.12.2006, p.5. One of the justifications for this Regulation is highlighted in Recital 3: "*In view of disparities between the laws of Member States and the consequent risk of distortion of competition, for some contaminants Community measures are necessary in order to ensure market unity while abiding by the principle of proportionality*".

⁷² Regulation (EC) No. 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC, OJ L 70, 16.3.2005, p.1.

or frozen); pulses (dry); oilseeds and oilfruits; cereals; tea, coffee, herbal infusions and cocoa; hops; spices; sugar plants; etc.

In addition, **Commission Regulation (EC) No. 2073/2005**⁷³ lays down **microbiological criteria for foodstuffs**. Food business operators must ensure that foodstuffs comply with the relevant microbiological criteria set out in Annex I to this Regulation, which includes (depending on the food category) testing for, e.g., *Listeria monocytogenes*, *Salmonella*, and shiga toxin producing *E.coli* (STEC) O157, O26, O111, O103, O145 and O104:H4.

With regard to agricultural products, the above regulations focus on the quality of the product. They strongly rely on inspections at the production, processing and distribution stages⁷⁴, rather than on risk management measures to prevent the contamination of products where they are grown.

Furthermore, **Regulation (EC) 852/2004 on the hygiene of foodstuffs** refers to 'potable water' and 'clean water'. Food business operators have to ensure the water that is used meets the requirements of the Regulation, which covers food processing operations but also primary food production (hence the references to 'potable water' and 'clean water' also apply to irrigation water for food crops). 'Clean water' is defined as 'clean seawater and fresh water of a similar quality' ('clean seawater' being defined as 'natural, artificial or purified seawater or brackish water that does not contain micro-organisms, harmful substances or toxic marine plankton in quantities capable of directly or indirectly affecting the health quality of food'). The Regulation also includes the following requirement: 'Recycled water used in processing or as an ingredient is not to present a risk of contamination. It is to be of the same standard as potable water, unless the competent authority is satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form'.

2.4.2.2 Links with other EU policy initiatives

Water reuse implementation also contributes towards other EU ambitions such as:

- The forthcoming **EC policy framework on phosphorus**, which will aim to enhance its recycling, foster innovation, improve market conditions and mainstream its sustainable use in EU legislation on fertilisers, food, water and waste. The development of this policy framework was announced in the Commission's 2014 Communication 'Towards a Circular Economy'⁷⁵.
- The **resource-efficient Europe initiative**⁷⁶, which underlines the importance of the sustainable management of water;
- The **EU biodiversity strategy**⁷⁷, as water reuse can contribute to the protection and restoration of aquatic life and water-dependant ecosystem services;

⁷³ Commission Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs, OJ L 338, 22.12.2005, p.1.

⁷⁴ Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety, OJ L 31, 1.2.2002, p.1. See in particular Article 17 laying down the responsibilities of food and feed business operators, and of Member States (system of official controls), and Articles 18-20.

⁷⁵ 'Towards a circular economy: A zero waste programme for Europe' (COM(2014) 398final)

⁷⁶ A resource-efficient Europe – Flagship Initiative under the Europe 2020 Strategy (COM(2011) 21) (http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf)

⁷⁷ COM(2011) 244 final

- The **EU climate change adaptation and disaster prevention** policies, in particular by reducing the vulnerability to droughts; and
- The **European Initiative on Smart Cities** aiming to support cities and regions in taking ambitious and pioneering measures to reduce greenhouse gas emissions through sustainable use and production of energy; urban water reuse may be supportive to other aspects of urban development, such as contributing to greener or climate proof cities, to more local sourcing of water and reduced use of resources.

Other EU policies whose objectives should be taken into account when designing further EU actions on water reuse, in particular, the 2006 **Thematic Strategy for Soil Protection**⁷⁸ which aims to protect soil while using it in a sustainable manner, through the prevention of further degradation, the preservation of soil functions and the restoration of degraded soils. The prevention of further degradation encompasses the issues of soil contamination by hazardous substances or excessive soil salinity, among others. Such issues need to be taken into account when implementing water reuse schemes. EU actions to further promote sustainable land management and reduce soil degradation will be defined in the forthcoming Commission's Communication on Land as a Resource (planned for 2015).

2.4.3 Policy measures in EU Member States

This section aims to describe national policy measures that are going beyond the EU policy framework related to water reuse.

2.4.3.1 *Comparison of water reuse standards*

The need to minimise health and environmental risks associated with water reuse practices has led to the development of **guidelines and regulations on the safe use of reclaimed water in six MS (CY, ES, IT, FR, EL and PT)**. A comparison of these water reuse standards⁷⁹, also covering key international standards, is presented in Annex B and summarised in the paragraphs below. Further comparative analysis can be found in the JRC report 'Guidelines for better water reuse in Europe' (Alcalde-Sanz et al., 2014).

Legal status of the standards

In all the EU MS where standards exist, they have a legally-binding status, except in PT. In PT, however, water reuse permit conditions (which are legally-binding) are based on the standards. Among the non-EU standards reviewed, only Californian standards have a legally-binding status; other standards reviewed (Australia, UNEP, USEPA, WHO) have a guidance status.

Types of wastewater

All the standards reviewed cover treated wastewater from municipal WWTPs. In two EU MS (EL and IT), industrial wastewater is also expressly covered. The Australian standards also cover greywater and stormwater⁸⁰.

⁷⁸ COM(2006) 231

⁷⁹ The term 'standard' used in this report refers to different types of documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that water reuse projects achieve an acceptable level of health and/or environmental protection.

⁸⁰ Greywater being defined as wastewater from kitchen, laundry and bathroom drains (but not from toilets). Stormwater being defined as rain draining into the stormwater system from roofs, roads, footpaths and other ground surfaces.

Use categories and restrictions

Each standard specifies which uses are covered. These different uses may then be grouped into wider categories. Although there are similarities between the uses and categories covered by the different standards, they never match perfectly (definitions for these categories are not homogeneous). Most importantly, the number of categories varies significantly; for example, IT has only defined 3 use types while ES has 24 use types grouped into 14 categories and California has 47 use types grouped into 4 categories.

In addition, in three EU MS the standards specify some prohibited uses:

- In CY: irrigation of leafy vegetables, bulbs or tubers that are eaten raw;
- In ES: water intended for human consumption (except in catastrophe situation), use in hospitals, bathing water, fountain or ornamental products in public spaces, and all other uses presenting health risks; and
- In FR: irrigation with raw sewage, irrigation with treated wastewater from WWTPs connected to certain animal by-products processing installations, irrigation with treated wastewater from WWTPs whose sewage sludge do not comply with applicable limit values, irrigation with treated wastewater on soils that do not comply with limit values specified by the national legislation on agricultural use of sewage sludge, irrigation with treated wastewater within the close protection perimeters of drinking water abstraction points (with some exceptions).

Approach

Three main types of approaches can be distinguished:

1/ An approach based on **limit values** defined for a range of parameters of the reclaimed water

By complying with these numerical limit values, health and/or environmental risks are deemed to be minimised. The limit values may be applicable at different points, depending on the standards (e.g. at the reclaimed water delivery point or at the outlet of the WWTP).

This approach is the one followed in the six EU MS reviewed. Specificities in two MS are worth being noted:

- In CY, requirements on water reuse are part of the municipal wastewater treatment regulations (as almost 100% of treated sewage is reused).
- In FR, requirements on water reuse are strongly linked with the national legislation on the agricultural spreading of sewage sludge: not only the quality of the reclaimed water shall be monitored, but also the quality of the sewage sludge produced by the WWTP and the quality of the agricultural soils.

2 / An approach based on wastewater treatment requirements and limit values

This approach is the one adopted by California (Title 22 of the Code of Regulations). For each potential use, a specific wastewater treatment technique is required. California has a system for approving and certifying treatment technologies under Title 22. In addition, for certain use categories, water quality criteria can apply (numerical limit values).

The USEPA guidelines also follow this type of approach.

3 / An approach based on the implementation of a risk management system for each reuse project

This approach is the one adopted by the Australian and the WHO guidelines.

An advantage of this approach is that it involves identifying and managing risks in a more proactive way, rather than relying on post-treatment testing and reacting when problems arise. It is also more flexible as it may be applied to a wide range of situations. First, the main health and environmental risks need to be identified and assessed, then measures to prevent and control the risks have to be implemented, followed by the implementation of monitoring procedures to check the risks are effectively reduced to an acceptably low level.

The Australian guidelines specify the log removals of enteric pathogens for different treatment processes as well as the required log reductions for water reuse categories. The guidelines also provide an indicative list of parameters that may be relevant for monitoring.

The Australian guidelines for drinking water augmentation and the WHO guidelines recommend the definition of health-based targets to manage health risks. Such targets measure the gap between current health status and an ideal health situation using DALY per year and per person units (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life). The guidelines also provide an indicative list of parameters for the validation, operational and monitoring stages of the water reuse scheme.

Parameters and limit values

There are large disparities in the number of parameters associated with limit values (where they exist). For example, while FR defines 6 water quality parameters, IT defines 55 parameters, EL has up to 80 parameters and ES up to 90 parameters. In a country like Spain, monitoring costs can therefore become significant for water reuse scheme operators as well as competent authorities in charge health and environmental inspections.

In addition to significant differences observed between the EU MS, different limit values may apply within the same country. In IT, regional authorities are allowed to set limit values other than those mentioned in the Decree; as a result, in Emilia Romagna and Puglia regions, microbiological quality criteria are similar to those of the California Title 22 guidelines while in Sicily they are similar to those of the WHO guidelines.

In FR, as already mentioned, not only the quality of the reclaimed water shall be monitored, but also the quality of the sewage sludge produced by the WWTP and the quality of the agricultural soils. Compliance is checked against the limit values specified by the national legislation on agricultural spreading of sewage sludge.

A recent French study pointed out that countries which recycle the largest volumes of treated wastewater are also those which have the lowest number of mandatory quality criteria and the easiest parameters to monitor (French Environment Ministry, 2014). The study takes Israël and Italy as two extreme examples: Israël is recognised as a leader in water reuse and has defined less than a dozen of parameters, while Italy has defined more than 50 parameters but only recycles a small proportion of its wastewater.

Monitoring

Most of the standards require or recommend minimum frequencies for sampling and analysis of the reclaimed water.

Depending on the standards, water samples may be taken from different points (e.g. outlet of WWTP, reclaimed water delivery point).

Responsibilities for water quality monitoring and the possible communication of monitoring results are defined in different manners in the standards. Depending on the standards, responsibilities fall on the WWTP operator and/or the reclaimed water network operator and/or

the final user. Because monitoring can be quite costly, these determinations of responsibility can have significant implications for the implementation of the standards.

In FR, the monitoring also covers the accumulation of contaminants in the sewage sludge produced by the WWTP (at least four times a year) and in agricultural soils (every 10 years). Sewage sludge quality is monitored because it is considered as a reliable indicator of the overall WWTP efficiency with regard to the removal of pathogens and other hazardous substances.

Application controls

A majority of standards require or recommend application control measures. They relate to the manner in which the recycled water is used. For example: adequate design to avoid cross contamination risks between the reclaimed water network and the drinking water network; clear signalling of the various elements of the reclaimed water distribution network in order to avoid confusion with the drinking water network; restrictions on crop types to be irrigated; setback distances between areas irrigated with treated wastewater and specific sensitive areas (e.g. drinking water supply wells), protection with tree curtains in the case of spray irrigation; access restrictions for the public and for animals (e.g. milking animals), etc.

Permitting system

In EU MS where standards are in place, there are also associated permitting processes for water reuse schemes. Permit application requirements are either specified by the water reuse standards, or they are set by other national regulations (e.g. on wastewater discharge).

2.4.3.2 Influence of standards on water reuse uptake

A comparison of MS with regard to their water reuse practices and the existence of water reuse standards is presented in Table 4 below. The review of water reuse practices in the MS shows that the reuse of reclaimed water is common practice in eight MS. Among these MS, all have water reuse standards in place, with the exception of BE and MT. In MT, however, standards are currently being developed. In BE, according to government representatives, the main applications of water reuse are industrial applications – for which the absence of standards is not considered to be an issue – and drinking water production through groundwater recharge, which has to comply with clear national requirements transposing the EU Directives.

In most MS where water reuse is widely practised, the need for regulation and standards has been considered essential in order to protect public health and increase consumer confidence. The influence of water reuse standards on the attractiveness of water reuse solutions, however, differs among the six MS concerned. According to government representatives, the implementation of water reuse standards has been a key element to support the development of water reuse in ES and CY, but in these two MS there are also strong economic drivers due to high water stress. The situation is very different in FR, EL and IT, where the administrative burden associated with the implementation of the national standards is seen as a barrier to the further uptake of water reuse solutions. In PT, in spite of national standards and supporting guidance documents, volumes of reused water remain far below the national target set for 2013, due to a number of obstacles, including the high administrative burden to obtain permits.

Table 4: Comparison of MS with regard to water reuse practices and standards in place

MS	Reuse of reclaimed water is common practice*	Standards for reuse are in place (national and/or regional)	Comments
AT			The Federal Water Law sets the legal framework for irrigation in Austria, by regulating water withdrawals from ground or surface water, but also irrigation water quality.
BE	X		According to available information, water reuse is mainly applied for industrial purposes or drinking water purposes.
BG			
CY	X	X	
CZ			
DE			There is a German standard on 'Hygienic concerns of irrigation water' which lays down quality criteria for irrigation water (voluntary standard developed by the German standardisation institute) ⁸¹ .
DK		Under development	The main application targeted by the future standards is the reuse of treated urban wastewater by the food industry.
EE			According to the Environment Ministry, the national legislation prohibits the reuse of treated urban wastewater; however, the possibility of implementing water reuse standards is now being considered.
EL	X	X	
ES	X	X	
FI			
FR	X	X	
HR			
HU			
IE			
IT	X	X	
LT			
LU			
LV			
MT	X	Under development	
NL			
PL			
PT	X	X	
RO			
SE			

⁸¹ DIN 19650: Bewässerung - Hygienische Belange von Bewässerungswasser (<http://www.naw.din.de/cmd?level=tpl-art-detailansicht&committeeid=54739067&artid=10573159&languageid=en&subcommitteeid=54778402&bcrumblevel=1>)

MS	Reuse of reclaimed water is common practice*	Standards for reuse are in place (national and/or regional)	Comments
SI			
SK			
UK			

* For further details on main uses per MS, see TYP SA 2013

Another conclusion that can be drawn from the above table is that, up to now, water reuse standards have only been implemented in MS experiencing water stress in one or several of their river basins. The situation may be changing in future years, while we see a country like DK – which is not subject to water scarcity issues – also developing water reuse standards. In DK, the chief motivation for promoting water reuse is the willingness to conserve the high-quality groundwater resources for the most sensitive uses (i.e. drinking water production) in the long-term, considering the existence of increasing pressures on such resources.

The existence of standards regarding the quality of conventional water used for irrigation has not been identified in the MS, except in AT (legally-binding) and in DE (not legally-binding) (see the comments in the above table).

2.4.3.3 Other policy measures

Other types of policy measures regulating and/or favouring water reuse have been implemented in some MS, such as:

- **Permitting requirements** (including prohibition of using freshwater for certain uses⁸²);
- **Economic instruments**;
- **Awareness raising actions**; and
- **National or regional targets** on water reuse.

With regard to economic instruments, it is worth noting that two MS (CY and MT) have the selling prices of reclaimed water set by legislation; in Cyprus, this price has been set at a lower level than the price of freshwater, in order to promote reuse.

A summary of existing or forthcoming policy measures is presented in Annex E. This summary also includes information provided by the MS on the **evaluation of their existing policies** (effectiveness, success factors, costs, main obstacles and counter-effects, etc.), where available. In addition to the policy measures summarised in Annex E, MS have implemented a number of **economic instruments** that may **indirectly promote water reuse** (e.g. water pricing specificities, abstraction taxes). Such financial incentives are described in a recent report by the EEA (EEA, 2013).

⁸² For example, in many Spanish regions, it is not allowed to irrigate golf courses with freshwater. This creates a strong incentive to use reclaimed water.

2.5 Problem definition

As acknowledged by the Blueprint (EC, 2012), water reuse is considered as an effective way of helping to solve the water scarcity and droughts issue in the EU, and reduce the contamination burden from wastewater, as well as the costs of treatment. In certain situations, it may also have a lower environmental impact than other alternative water supplies such as water transfers or desalination. Studies conducted as part of the Blueprint, as well as more recent works (e.g. Forzieri et al., 2014), have shown that climate change will substantially increase the severity and length of droughts in Europe by the end of the century. Demand for water is likely to exceed available amounts across many river basins throughout Europe. Southern Europe would be most affected by drought, with flow levels of rivers and streams in the Iberian Peninsula, south of France, Italy and the Balkan region reduced by almost 40% due to climate change alone (Forzieri et al., 2014).

Although the reuse of reclaimed water is an accepted practice in several EU countries experiencing water scarcity issues (e.g. Cyprus, France, Greece, Italy, Malta, Portugal, Spain), where it has become an integral and effective component of long-term water resources management, overall only a small proportion of reclaimed water is currently reused in the EU. As described in Section 2.2, only about **1,100 Mm³/y** of reclaimed water is estimated to be currently reused in the EU, accounting for about 2.4% of the total volume of treated urban effluents⁸³ and 0.4% of total freshwater withdrawal (with large disparities across the MS). Under a baseline scenario with no further EU policy action to foster water reuse, no significant increase in water reuse is expected to occur. However, the EU potential for water reuse is considered to be much larger: a volume in the order of **6,000 Mm³/y by 2025** might be achievable in the case of stronger regulatory and financial incentives at the EU level – this situation would correspond to a water reuse rate equivalent to 4% of total annual freshwater withdrawals in six MS (ES, IT, DE, FR, PT, EL), in line with the existing Spanish water reuse target for 2013⁸⁴, with a situation similar to the BAU scenario in the other MS (see Section 2.3). While the above data are only very rough estimates and will need to be refined by some detailed modelling work, they provide some initial indications on the overall trends and on the potential for further uptake of reuse solutions.

It is important to note that the potential contribution of water reuse towards addressing water scarcity should not be analysed based on overall figures at the EU level: 6,000 Mm³/y (as mentioned above) would still only represent a very small proportion (~2.5%) of total EU freshwater withdrawals⁸⁵. Water reuse is first a local solution and the contribution it can make to address water stress needs to be analysed at a national, regional or river basin scale: at such smaller scales, an increased rate of water reuse could significantly contribute to reducing water scarcity, as demonstrated in the MS that already use this alternative supply solution⁸⁶.

The problem to be addressed can be summarised as follows: **in spite of its numerous advantages and development potential, the reuse of reclaimed water is not widely implemented in many MS.** While the reuse of water may not be an appropriate solution in all

⁸³ Assuming this percentage has remained stable since it was estimated in 2006 as part of the AQUAREC project (Hochstrate et al., 2006)

⁸⁴ The assumptions associated with this estimate are described in Section 2.1.1.

⁸⁵ Estimated at 237,660 Mm³/y in 2011 (<http://www.indexmundi.com/facts/european-union/annual-freshwater-withdrawals>, accessed 01.09.14)

⁸⁶ For example, in Cyprus, the current objective is to replace 40% of agricultural freshwater requirements by reclaimed water. In Catalonia, achievement of the 2015 water reuse target would enable 30% of the conventional water demand to be met by recycled water.

places and circumstances, for technical and/or economic reasons⁸⁷, there are many lost opportunities to develop water reuse schemes.

This problem affects a wide range of actors, in particular as:

- Economic sectors that are highly dependent on water supply, in terms of availability and quality, such as **agriculture**, the **food industry**, the **power generation industry** (e.g. for cooling processes and hydropower) and the **tourism and recreational industry** (e.g. golf courses): not exploiting the full potential of water reuse in these sectors increases their vulnerability to water scarcity and droughts, with all the socio-economic consequences it may have, and deprives them of potential economic savings through e.g. the recycling of nutrients.
- The **EU water industry**, because of lost business opportunities in the area of water reuse, while reuse technologies represent a significant area for further innovation and there is a growing worldwide market for such technologies.
- **Public authorities**, through the cost of water supply, wastewater treatment and implementation of the 'programmes of measures' under the WFD⁸⁸: not taking advantage of water reuse opportunities represents lost cost saving opportunities, e.g. by reducing drinking water supply production needs and associated costs, by limiting the needs to install expensive nutrient removal processes in urban WWTPs (when such nutrients can be recycled through agricultural irrigation) or by reducing expenses associated with the implementation of 'programmes of measures' (water reuse may significantly contribute to meeting environmental objectives);
- **Society at large**, which cannot fully take advantage of the wide range of environmental, economic and social benefits associated with water reuse.
- The **environment**, because of overexploitation of water resources and nutrients, and missed recycling opportunities.

The effects of the problem on these different actors are further described in Section 2.8.

2.6 Problem drivers

The underlying causes of the problem can be described as a combination of **market failures** (mainly with regard to **market prices** and **information failures**), **regulatory failures** (mainly in the form of implementation and enforcement issues with regard to **EU water legislation**) and **technical/scientific** challenges. Six main types of issues have been identified. They are described below, together with their underlying causes and the key actors affected. The first two issues (1/ Inadequate pricing and business models and 2/ Insufficient control over freshwater abstraction) are equally considered to represent the most significant barriers to a wider uptake of water reuse solutions; the next four issues are presented by decreasing order of importance⁸⁹.

⁸⁷ For example, there are many situations where reuse would not be cost-effective due to the distance between offer and demand, the need for significant storage infrastructure, or the need for expensive treatment requirements. Such situations are not considered in the problem definition.

⁸⁸ The environmental and resource costs, which are rarely reflected in water prices, can be significant when it comes to the implementation of programmes of measures.

⁸⁹ This hierarchy between the different issues is proposed based on a review of the literature and an analysis of opinions expressed during the stakeholders' consultation and the public consultation.

Issue 1: Inadequate water pricing and business models

This first issue is relevant to all types of water reuse applications.

Even where it is technically feasible, regarded as safe and publicly acceptable and where treatment costs are not disproportionate with regard to the expected benefits, water reuse may face economic barriers related to costs and insufficient incentives for uptake. High investment costs are often compounded by low financial returns. This can be attributed to a number of price, information and regulatory failures within the EU water sector.

There are **insufficient price differentials** between reused water and freshwater, exacerbated by a **lack of full cost recovery** within most EU water markets and the existence of public subsidies to conventional water resources in many EU areas. This is both a **regulatory failure** (improper implementation of Art. 9 of the WFD related to water pricing and cost recovery) and a **market failure** as prices of conventional resources and reused water do not reflect their actual cost, leading to limited economic attractiveness of water reuse projects and improper decisions by water users and decision makers. The issue of incorrect water pricing is further developed in the IA of the Blueprint (EC, 2012), as one of the key problem drivers to be addressed. A comprehensive review of barriers to cost-recovery water pricing can be found in a recent report by the EEA (EEA, 2013).

Existing freshwater prices typically fail to account for the range of external costs associated with the abstraction, purification and discharge cycle – which are typically borne by taxpayers in many cases. This disincentivises the demand for reused water and associated returns on investment, in the absence of price support. Since many of the benefits of water reuse are public goods for which compensation mechanisms may not exist, water service providers may see limited financial incentives to encourage reuse. These economic barriers are discussed in more detail in Section 2.8.2.

The **lack of integrated delivery models** within the EU water sector is another limiting factor, and particularly the frequent separation of water supply and wastewater treatment. This can increase the costs of reuse, as well as complicating the distribution of costs and benefits and making it difficult to ensure that the full costs and benefits are adequately accounted for. This point is connected to Issue 5 ('Reuse not seen as a component of integrated water management approaches').

EU actions to better enforce the water pricing provisions of the WFD are included in the Blueprint (e.g. development of further guidance on cost recovery), however a large part of the enforcement efforts lies with the national and regional authorities. According to the Blueprint (EC, 2012), only 49% of River Basin Management Plans intend to change the water pricing system to foster a more efficient use of water. The barriers to water reuse related to inadequate water pricing are therefore unlikely to change significantly, in the absence of any further EU action targeting the economic drivers of the problem.

Issue 2: Insufficient control over freshwater abstraction

This second issue mainly concerns agricultural irrigation applications.

As highlighted in the Blueprint, there are many situations where access to conventional water resource is insufficiently controlled by public authorities, resulting in both **over allocation** (abstraction permits going beyond available resources, including situations where no maximum amount is set in permits) and **illegal abstraction** (when permits are not enforced, in particular because of no monitoring of actual abstractions).

The fact that the raw freshwater is abstracted for free (illegally) or is over-allocated contributes to maintaining a low level of demand for reclaimed water. This issue can be considered as a **regulatory failure** as it results from improper implementation of the WFD provisions⁹⁰. If all abstraction activities were duly authorised, if the allocation of freshwater volumes was consistent with the available resources at the river basin scale and if all abstraction permits were complied with, the use of reclaimed water would become a more attractive alternative in water-scarce areas.

EU actions to prevent over-allocation and illegal abstraction have been proposed by the Blueprint, however a large part of the enforcement efforts still lies with the national and regional authorities.

Issue 3: Economic and technical uncertainties for decision-makers

There are a number of economic, technical and societal issues which limit consumer willingness to pay for reused water and hence its ability to compete with freshwater resources. These issues create uncertainties for potential project developers or investors interested in water reuse. Some of these issues (lack of stakeholder awareness) are relevant to all water reuse applications, while others are related to more sensitive applications in food irrigation and other applications with a high chance of direct human contact (according to Plan Bleu-UNEP (2012), there is strong evidence of a 'proximity effect' on willingness-to-accept water reuse, for example, with high willingness to accept distant environmental application, lower willingness to accept household or non-potable applications, and very low WTA agricultural produce irrigated with wastewater). Another issue (unclear regulatory framework) is specific to some MS and is relevant to some water reuse applications that are not fully covered by EU legislation.

First of all, the low levels of demand for water reuse are partly due to the **lack of stakeholders' awareness concerning the benefits of water reuse (information failure)**. In addition to the most obvious benefits (mitigation of economic risks related to water scarcity, conservation of the aquatic environment, cost savings for utilities), there are a host of benefits that stakeholders are not aware of. These benefits are described in detail in Section 2.8. The consequence is a limited interest from potential decision-makers (businesses, public authorities, developers, planners, asset investors, etc.) in water reuse solutions.

No matter how technically sound and scientifically justifiable the water reuse schemes are, they can fail for a lack of **public acceptance**. Reuse for potable purposes meets with the strongest opposition but, even for non-potable reuse purposes, public attitudes such as perception of water quality play an important part. Perceived health risks may result from a lack of public knowledge and misconceptions on what 'reclaimed water' means and how it may be used. The acceptance of water recycling is a social factor with a high emotive content. Further analysis of public acceptance issues is provided in Section 2.8.3.

A third reason for the low levels of demand for reclaimed water is the **fear of trade barriers on agricultural goods** that have been grown using reclaimed water for irrigation. Stakeholders argue that the lack of harmonisation between existing water reuse standards creates tensions

⁹⁰ The following measures are listed among the basic measures to be included in the Programmes of Measures for each river basin (Article 11-3-c of the WFD): 'Controls over the abstraction of fresh surface water and groundwater, and impoundment of fresh surface water, including a register or registers of water abstractions and a requirement of prior authorisation for abstraction and impoundment. These controls shall be periodically reviewed and, where necessary, updated. Member States can exempt from these controls, abstractions or impoundments which have no significant impact on water status'.

between MS⁹¹. Based on the information reviewed and discussions with stakeholders, there is no evidence of actual trade barriers but this potential risk has been raised by many stakeholders and has been put forward by the Blueprint as a key aspect to be addressed. For example, potential trade barriers are a significant concern for Cyprus, where almost 100% urban wastewater is reused, including for agricultural irrigation; while most agricultural production is currently consumed within the island, exports are projected to increase in future years, hence it is important for Cyprus to ensure the absence of trade barriers related to water reuse practices⁹².

One could argue that the safety of agricultural products irrigated with reclaimed water is ensured by EU food safety legislation⁹³, in particular Regulation (EC) No. 1831/2003 setting maximum levels for certain contaminants in foodstuffs, Regulation (EC) No. 396/2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin, and Regulation (EC) No. 2073/2005 on microbiological criteria for foodstuffs (see Section 2.4.2.1). Hence, EU food safety legislation could be seen as sufficient to prevent internal trade barriers.⁹⁴ However, EU food safety legislation relies upon inspections carried out on products, therefore it needs to be supported by upstream risk management measures in order to prevent the contamination of products during irrigation.

Finally, in some MS where no water reuse standards are in place (i.e. MS other than CY, ES, FR, EL, IT, and PT), there is a **lack of clarity in the regulatory framework to manage health and environmental risks**, and a **lack of confidence in the health and environmental safety** of water reuse practices. These issues are relevant to water reuse applications for which the quality of the supply water is not specifically regulated at the EU level, i.e. mainly for uses other than drinking water production, groundwater recharge and bathing. The main applications concerned by these issues are therefore **agriculture, urban uses, industrial uses** and **recreational uses** (such as irrigation of golf courses).

As described in the policy context (Section 2.4.2.1), the health and environmental safety conditions under which wastewater may be reused are not clearly specified by EU legislation for applications such as agriculture, urban uses, industrial uses and certain recreational uses. The health and environmental risks to be managed are described in further details in Sections 2.8.1 and 2.8.3. In addition to the lack of common EU standards on water reuse, there are uncertainties with regard to potentially applicable legislation that need to be taken into account when issuing permits for reuse projects. These barriers are commonly mentioned by reuse scheme developers in the UK. For instance, in order for the Water Safety Plan of the London Olympic Park water reuse scheme to be accepted (toilet flushing and irrigation uses), it had to go through every relevant agency and regulatory body (UK Environment Agency, Health Protection Agency, Drinking Water Inspectorate), which increased considerably the time for obtaining an authorisation.

⁹¹ The case of Germany having falsely accused cucumbers from Spain as the cause of a deadly E. coli outbreak in 2011 is often quoted as an example by the stakeholders.

⁹² Verbal information from the Environment Ministry of Cyprus

⁹³ According to Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law: "Food shall be deemed to be unsafe if it is considered to be: (a) injurious to health; (b) unfit for human consumption" (Article 14); "Feed shall be deemed to be unsafe for its intended use if it is considered to: - have an adverse effect on human or animal health; - make the food derived from food-producing animals unsafe for human consumption" (Article 15).

⁹⁴ One of the justifications for Regulation (EC) No. 1831/2003 is highlighted in Recital 3: "In view of disparities between the laws of Member States and the consequent risk of distortion of competition, for some contaminants Community measures are necessary in order to ensure market unity while abiding by the principle of proportionality".

In France, while irrigation uses are covered by national standards, there is no clear regulatory framework for other relevant uses such as street washing or fire-fighting water; according to the water industry, this situation is unfavourable to the development of water reuse schemes⁹⁵. Furthermore, according to the French water industry, while the current national standards include very stringent requirements in terms of management measures (prevention, control and monitoring measures, administrative process, etc.), the requirements in terms of results to be achieved (quality criteria) may not be sufficient to ensure the safety of reuse practices.

WssTP commented that *'a lack of clear regulation which covers a wide range of reuse scheme forms also makes commercial actors and investors nervous of operating in an area with poor legal clarity and legitimacy'* (WssTP, 2013). Referring to Art. 12 of the UWWTD⁹⁶, EUREAU commented that *'the appropriateness of an application is not legally defined in EU legislation and this creates confusion and reduces the opportunity for beneficial projects'* (EUREAU, 2004).

It is likely that additional MS would adopt their own water reuse standards in the near future. For example, DK and MT already have plans to develop their own standards. In those MS, such new standards are expected to provide more clarity to the stakeholders on the required measures to manage health and environmental risks. However, in the absence of further EU action specific to water reuse, uncertainty on how to apply the existing EU legislation to manage risks of water reuse projects would persist in the other MS. As observed in the past, possible new national standards to be developed may differ widely from one country to another, except if the forthcoming ISO standards become a widely used reference.

The other issues discussed above are not likely to be solved in the near future without additional EU efforts in terms of knowledge exchange, awareness raising and harmonisation of practices.

Issue 4: Too stringent water reuse standards for the intended uses, in some Member States

In France, Italy and Greece, the existence of **too stringent water reuse standards** with regard to the intended uses has been raised as a key barrier to the further development of water reuse projects. This issue is relevant to water reuse applications covered by these national standards.

In Italy, legal quality standards have been set at the national level for agricultural, urban and industrial applications, but regional authorities may impose stricter quality standards. This has led to a situation where, in many regions, the quality standards for reclaimed water were similar to those for drinking water even for non-potable uses (Angelakis et al., 2007), limiting the economic attractiveness of water reuse schemes for potential investors. The requirement for full disinfection for all applications is also considered as too stringent by many stakeholders⁹⁷. Reportedly, complying with the standards involves significant costs⁹⁸, especially as existing WWTPs need to be refurbished. Another issue is the high number of quality parameters to be monitored (in excess of 50 parameters) and the high sampling frequency required in certain regions, entailing high monitoring costs. The approach taken by Italy is considered as a highly precautionary one, driven by a strong demand from consumers, farmers and food retailers to have a high level of safety (reuse of water is not well perceived in general).

⁹⁵ Communication with SYNTEAU (French federation of the water treatment industry)

⁹⁶ Article 12 of the UWWTD states that treated wastewater should be reused 'whenever appropriate'.

⁹⁷ Verbal information from an IWA expert

⁹⁸ Verbal information from the Italian Environment Ministry

In France, stakeholders reported that the relatively stringent standards for water reuse (covering the irrigation of agricultural and public areas) have also discouraged the further uptake of reuse solutions since 2006. Although the limit values contained in the standards are not necessarily very restrictive, the management measures are considered too stringent. As a consequence, before the standards' revision in 2014, the feasibility studies could be relatively expensive (up to EUR 200k). The slowdown in the development of water reuse projects has been exacerbated by uncertainties with regard to the national legislation on water reuse, which has been the subject of successive revision processes over the last few years⁹⁹.

In France, Italy and Greece, the complexity of the water reuse standards is actually seen as an obstacle to the further uptake of water reuse solutions, due to high administrative burden and associated costs for local authorities, reclaimed water suppliers and users.

The case of Estonia should also be mentioned: in this Member State, there are no water reuse standards in place, however the national legislation prohibits the reuse of treated urban wastewater¹⁰⁰.

In these Member States, the situation is likely to remain unchanged in future years (i.e. very few new water reuse projects) in the absence of EU action related to standards' harmonisation. In France, the only few projects that are still being pursued are for golf courses (where developers can more easily cover the costs for the feasibility assessments).

In these countries, stakeholders consider that possible future EU action would be an opportunity to modify the legislative context, so that it would become easier to implement in practice.

Issue 5: Reuse not seen as a component of integrated water management approaches

This issue is relevant to all types of water reuse applications.

Integrated water management is not sufficiently implemented and still in its infancy in certain EU regions. In particular, this is characterised by:

- **A fragmentation of responsibilities** for and authority over different parts of the water cycle;
- **Lack of communication and cooperation among stakeholders** involved in the whole water cycle in certain EU regions, in particular between **water supply** and **sanitation** stakeholders.

In many EU regions, the authority over the water supply sector resides in an entirely different organisation than that over wastewater management. This separation of powers leads to long periods of inaction, stalemate, disagreement, negotiation, and complex interagency agreements that make the resulting water reuse project far more costly and complex than need be (Alcalde-Sanz et al., 2014). Regions where the same authority manages water, wastewater, stormwater, and the watershed are far more nimble, implementing their water reuse projects quickly, efficiently, and at much lower cost (Sheikh, 2004). In order to implement an integrated and sustainable water management, it is necessary to bridge the tight but artificial compartments of

⁹⁹ Verbal information from the French Environment Ministry and the French federation of the water treatment industry (SYNTEAU)

¹⁰⁰ Verbal information from the Estonian Environment Ministry. The possibility of implementing water reuse standards is, however, being considered at present.

water supply and sanitation (Bixio et al., 2006). Too often water reuse is excluded from possible integrated water management scenarios, not being considered as a possible solution by stakeholders (Alcalde-Sanz et al., 2014).

A survey carried out as part of the AQUAREC project showed that communication and collaboration between the water and the wastewater sector is always desirable, as well as a well-designed cost allocation (Bixio et al., 2006). A best practice example was reviewed in the AQUAREC project, the Tilburg project (Netherlands), where the water supply and the wastewater services joined together to set up an *ad hoc* water reuse company under an administrative and legal framework that has tax advantages while at the same time having the ability to allocate funds at the lowest interest rate. The project could also fully benefit from the technical capacities of the two companies, namely: the wastewater treatment company for the management of the water reclamation scheme and the drinking water company for the distribution system and for the customer relations (Bixio et al., 2006).

This situation is in contradiction with one of the ambitions of the WFD, i.e. the achievement of sustainable and integrated water resource management. It results from the **poor level of implementation of the WFD** in certain EU regions. In the WFD, reuse of water is mentioned as one of the possible measures to achieve the Directive's quality goals, however this remains a relatively vague recommendation rather than a requirement: Part B of Annex VI refers to reuse as one of the '*supplementary measures which Member States within each river basin district may choose to adopt as part of the programme of measures required under Article 11(4)*'.

Besides, **Article 12 of the UWWTD**, concerning the reuse of treated wastewater, is **not specific enough to promote a high level of integration in water management**¹⁰¹. It leaves too much room for interpretation as to what can be considered as an 'appropriate' situation to reuse treated wastewater.

In the absence of further EU action, reuse possibilities will not be systematically evaluated as part of water management strategies; uptake of such solutions will continue to be mostly driven by the level of awareness and commitment of local stakeholders involved in water management projects.

Issue 6: Technical challenges and scientific uncertainties

This issue is relevant to all types of water reuse applications.

The water reuse sector in the EU is maturing both technologically and commercially, albeit at a slow rate. Where ten years ago the number of full scale operating schemes was limited there is now a considerable number of live projects of varying type and scale (WssTP, 2013). In general terms, treatment technologies exist to achieve any desired level of water quality, and the field is constantly developing as existing technologies are improved and new ones emerge¹⁰². However, these technological options vary widely in terms of their cost and feasibility for use in different environments and at different scales. Furthermore, research on the range of potential contaminants in wastewater, and their potential impacts on health and the environment, is

¹⁰¹ Article 12 of the UWWTD reads as follows: '*Treated wastewater shall be reused whenever appropriate. Disposal routes shall minimize the adverse effects on the environment*'.

¹⁰² For example, an evaluation of the removal efficiency of advanced wastewater treatment processes for reuse applications, for 100 micro-pollutants, was carried out by Ruel et al. (2011)

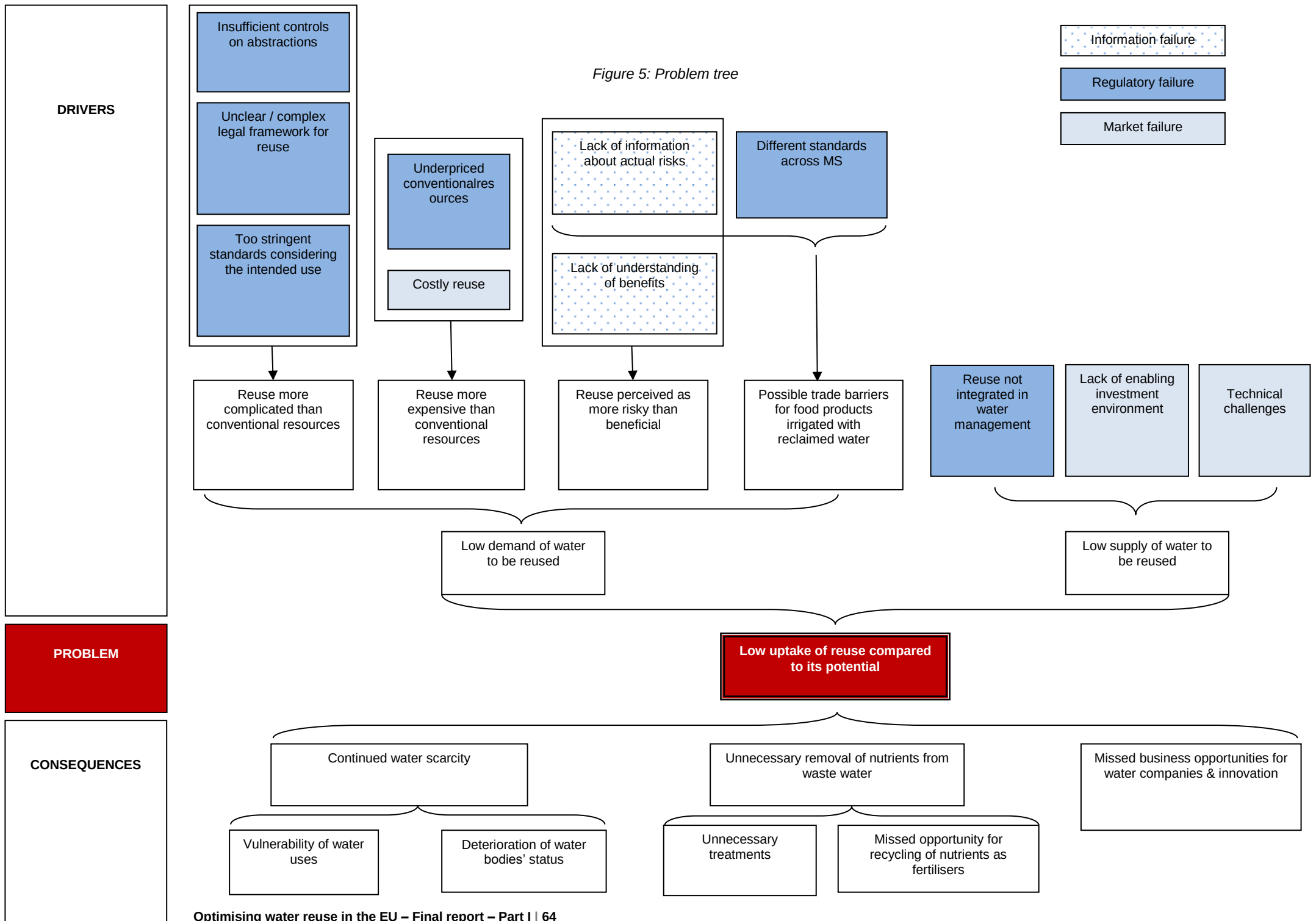
likewise evolving constantly. Therefore certain technical challenges and uncertainties persist in the sector, and these are identified as follows:

- **Contaminants of emerging concern** – CECs, or simply emerging contaminants, include a wide range of compounds such as residues from pharmaceutical, personal care products, pesticides, and industrial chemicals, as well as nanoparticles. This large and diverse group of compounds are rarely monitored in conventional wastewater treatment systems. Many have been detected at trace levels in wastewater discharges, receiving waters, and even drinking water supplies. However, there are three specific areas of uncertainty that are the subject of on-going research: 1) uncertainty over the extent to which they are removed within conventional and advanced treatment processes; 2) the lack of reliable, standardised methods for their detection and measurement; and 3) the lack of comprehensive toxicological data on their potential impacts on human health and the natural environment. These uncertainties hinder the development of regulatory quality standards and monitoring strategies for reuse schemes. While these uncertainties are relevant to all forms of reuse, they are of particular concern for reuse schemes that augment potable water supplies, either directly or indirectly, owing to the (albeit so far unquantified) potential for long-term human health impacts. The risk posed by these contaminants through agricultural reuse schemes is thought to be small (CSWRCB, 2010; Crook, 2010; NRC, 2012; ATSE, 2013; Alcalde-Sanz et al., 2014).
- **Rapid monitoring** – Traditional monitoring mechanisms for water treatment processes (particularly microbial monitoring) can be time consuming and labour intensive. This creates a particular concern for reuse schemes (potable or non-potable) that lack environmental buffers and, as a result, may have limited time to detect and address any failures in the treatment system before the water reaches consumers. There is thus a pressing need to develop rapid (even real-time) monitoring techniques that are reliable and cost-effective, in order to address this potential lag time (Crook, 2010; Alcalde-Sanz et al., 2014). Promising advances have been made with technologies such as flow cytometry (e.g. Prest et al., 2013; Gillespie et al., 2014) but further investigations are needed.
- In the **industry sector**, solutions are sometimes relatively complex to design and implement, with uncertainties concerning possible damages to industrial processes and possible product quality failures. Here, the underlying issues are the lack of adequate technical competencies to design reliable solutions and the negative perception of some industry stakeholders with regard to the quality of reclaimed water.
- Methods for **identification and optimisation of appropriate reclamation technologies** for the various reuse applications are inconsistent and unreliable (Alcalde-Sanz et al., 2014). The efficiency and reliability of secondary treatment in urban WWTPs is indeed a pre-requisite for the development of a reuse scheme.
- **Saline intrusion in sewage systems**: obsolete water transportation networks may cause reclaimed water to be contaminated by seawater, thus preventing its reuse due to a too high salinity. This issue is considered as a critical one to be addressed in islands such as Malta and Cyprus as well as in some Mediterranean coastal areas.

Water reuse technologies are evolving relatively quickly, therefore a number of the technical barriers identified are likely to be solved within the next ten years or so, either thanks to R&D work conducted by the water industry or thanks to publicly funded research programmes. The evaluation and management of risks associated with emerging pollutants is, however, a very complex issue and may require more significant efforts.

Problem tree

The links between the main problem drivers and their underlying causes are summarised in the problem tree below.



2.7 The need to act at EU level

The Union competence to take action on water management derives from Article 191 of the Treaty on the Functioning of the European Union related to the protection of the environment: *'Union policy on the environment shall contribute to pursuit of the following objectives:*

- *preserving, protecting and improving the quality of the environment;*
- *protecting human health;*
- *prudent and rational utilisation of natural resources; and*
- *promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.'*

EU action on water management is primarily justified because **60% of EU river basins are international**, shared by between two and nineteen countries (Danube). Action taken by a single or a few States is therefore not sufficient, for instance in relation to quantitative aspects of water management or cross border water pollution. Water management is also an issue for Enlargement and Neighbourhood policies.

As explained in the problem definition, uptake of water reuse solutions is strongly correlated to the **further implementation and enforcement** of the **WFD** and the **UWWTD**, hence EU level action is necessary to address these implementation issues. A higher uptake of water reuse solutions would in turn contribute to achieving some objectives of the WFD such as preventing the deterioration of the quality status of water bodies, ensuring a balance between abstraction and recharge, or protecting high quality water resources for the most sensitive uses. In coastal areas, it would contribute to achieving the goals of the **Marine Strategy Framework Directive**.

Water reuse has also proven to be a particularly beneficial solution in EU touristic coastal areas, where its implementation has allowed reaching compliance with the **Bathing Water Directive** (by avoiding the discharge of treated sewage into the sea), thus providing environmental and socio-economic benefits to these areas.

A wider uptake of water reuse would also contribute to achieving the objectives of several EU policy initiatives, in particular: the forthcoming EC policy framework on **phosphorus**, the **resource-efficient Europe** initiative, the EU **biodiversity** strategy, and the EU **climate change adaptation and disaster prevention** policies.

A significant barrier to water reuse is related to inadequate water pricing. The **basis for action on pricing** is the need to facilitate the implementation of the WFD, in particular Art 9. In order to be effective in cross-border basins and to prevent negative effects on the internal market, economic incentives to use water at its true cost for society should be applied in a consistent fashion in the EU. Moreover, the identification of **environmentally harmful subsidies** is an essential element of **Europe 2020**, and their reduction is part of the Resource Efficiency Roadmap. Further, the calculation of costs and benefits of water reuse schemes needs to be consistently applied across the EU in order to ensure a level playing field for implementation of Art 9 of the WFD.

Because agriculture irrigation is one of the reuse applications with the highest potential, EU action is justified to prevent that different requirements in individual jurisdictions negatively affect the **level playing field** (e.g. between farmers) and cause obstacles to the **internal market**, especially for agricultural products. On the one hand, disparities between the existing water reuse standards (in place in six MS) may generate differences in the production costs of food

products¹⁰³. More stringent standards will generally involve more advanced wastewater treatments and possibly also more elaborated risk management measures and monitoring requirements. Therefore, the **heterogeneous situation with regard to standards** across the MS may **not provide a level playing field**, especially for agricultural production. Moreover, if MS act alone, the technical barriers and associated costs are likely to be unnecessarily high. On the other hand, national representatives put forward their concerns over the fact that heterogeneous water reuse standards may also be used as an argument to restrict the export of food products from MS suspected of having lower standards¹⁰⁴. Such disparities may create **potential barriers to internal trade** and to the functional operation of the single market. Addressing such barriers is an appropriate EU level response, taking into account EU food safety, health, agriculture and energy policies. In this respect, some of the arguments put forward in the preamble of EU Regulation No 178/2002 on food safety are also relevant to the present assessment, in particular:

- *‘The free movement of safe and wholesome food is an essential aspect of the internal market and contributes significantly to the health and well-being of citizens, and to their social and economic interests’.*
- *‘The free movement of food and feed within the Community can be achieved only if food and feed safety requirements do not differ significantly from Member State to Member State.’*
- *‘There are important differences in relation to concepts, principles and procedures between the food laws of the Member States. When Member States adopt measures governing food, these differences may impede the free movement of food, create unequal conditions of competition, and may thereby directly affect the functioning of the internal market.’*

EU action on water reuse standards is also justified by the opportunity to overcome barriers to **innovation and business development** in technologies for water recycling. Technology providers in this sector are EU-scale companies and difference in standards across MS prevent companies to benefit from a clear framework allowing economies of scale and standardisation which would support innovation and development of solutions at lower costs. Considering that water reuse is an emerging worldwide market, a greater uptake of reuse at the EU level would provide a showcase for the relevance of these technologies and skills of EU companies towards potential customers in third countries.

¹⁰³ It is difficult to find data to support this argument, due to the various factors influencing differences in food production costs, however this is a potential concern raised by several Member States.

¹⁰⁴ No such issues have been reported to date, but this is a potential risk expressed by several Member States.

2.8 Environmental and socio-economic impacts of the baseline scenario

This section provides a description of the current environmental and socio-economic aspects relating to water reuse, as well as their likely evolution, under the baseline scenario. This baseline scenario can also be called 'business as usual' (BAU) scenario. It corresponds to 'Policy option zero' defined in Chapter 4, i.e. a policy option involving no further EU action in relation to water reuse.

While Section 2.2 describes the current status and possible future trends of water reuse uptake in the EU and in key MS, the present section provides a description of other environmental impacts and of socio-economic impacts associated with the baseline scenario. A series of key issues and impact indicators have been identified to describe the likely environmental and socio-economic aspects, supported by evidence from MS, where available.

In Chapter 4, the effects of a range of policy options on these issues and indicators are then analysed, in order to assess their potential impacts with regard to the baseline scenario.

2.8.1 Environmental aspects

The available data on current and future volumes of reused water under the baseline scenario are analysed in Section 2.2. The main conclusion is that, under the baseline scenario, the contribution of water reuse towards increasing water availability in the EU will remain negligible.

In addition to the benefits in terms of freshwater availability, there is a wide range of environmental benefits associated with reuse schemes, in particular:

- Reducing pressure on water bodies, maintaining ecological flows and protecting aquatic ecosystems;
- Preserving high-quality groundwater for more sensitive uses (e.g. drinking water production);
- Decreasing the nutrient pollution load discharged to rivers, and the associated risks of eutrophication;
- Improving the quality of irrigation water and bathing waters;
- Restoring or enhancing biodiversity and the various ecosystem services associated with wetlands;
- Protecting groundwater resources from saline intrusion, particularly in islands and coastal areas (through groundwater recharge);
- Reducing the amount of organic fertilisers applied to irrigated fields, thereby contributing to conserving natural resources of phosphorus and reducing environmental impacts associated with fertilisers' manufacture;
- Decreasing the level of purification/treatment necessary for discharging wastewater, thereby reducing energy consumption associated with water treatment.

Because the uptake of water reuse solutions will remain very limited at the EU level in the baseline scenario, these other benefits are unlikely to materialise at a wide scale across the EU.

2.8.2 Economic aspects

2.8.2.1 Price of reclaimed water and cost of reuse solutions

Water reuse schemes remain relatively underdeveloped in the EU owing to a lack of economic attractiveness and perceived low returns on investment. Many existing reuse schemes have benefited from direct or indirect subsidy to support both supply and demand, but this is at odds with the need for cost recovery and financial sustainability in water sector. Given the existing structure and level of pricing for freshwater, there is a need to look for policy measures that ensure the financial sustainability of water reuse schemes without generating supplementary costs for water users. Three parameters for policy options can be identified: pricing and cost recovery; consumer demand; and delivery models.

Pricing and cost recovery

Water pricing for water services in the EU is defined within Article 9 of the Water Framework Directive according to the principle of cost recovery (including environmental and resource costs) as well as the polluter-pays principle (proportionality to the pressures imposed on aquatic ecosystems by the main water users). Evidence available suggests that, at best, only financial costs of water treatment and distribution are included in tariffs: few MS apply direct charges to polluters for the purification of their wastewater as well as other activities that impact on water quality, and charging for the resource costs of water abstraction is rare (EEA, 2013). Furthermore, whilst financial cost recovery is high for domestic users, in agriculture low levels of cost recovery (20-80%) point to heavy subsidisation of freshwater use, even in water-scarce Mediterranean countries (EEA, 2013).

The persistence of such regulatory and price signals would dis-incentivise both water efficiency and water reuse by failing to account for the full external costs of freshwater abstraction and wastewater discharge. Because these external costs are typically borne by taxpayers, price support measures for water reuse may be justified, to enhance its competitiveness. This is the case in two MS where water reuse schemes have significant uptake (Spain and Cyprus) and subsidies, together with an integrated supportive regulatory regime. However these cases remain highly atypical for the EU overall, and concerns over their financial sustainability persist.

Although the dominant uses of reclaimed water in such regions are irrigated agriculture and landscape irrigation, growing demand from urban centres and tourism is contributing to increased local competition for water resources. Costs can be expected to increase substantially in the absence of remedial solutions such as reuse.

In this context, water reuse may be favourable in comparison to other unconventional sources (Plan Bleu, 2012). Reclaimed water in Spain's Segura river basin, for example, is sold to irrigators at around EUR 0.12/m³. Whilst this represents a fraction of the estimated 0.40 EUR/m³ cost including capital, operational and environmental expenditures, this compares favourably with 1 EUR/m³ for equivalent desalinated supplies and 99% of available wastewater resources are currently reused (GWI, 2012a).

Competitive tariffs for water reuse (at or below those of fresh water) have been seen as essential to drive uptake: given the higher salinity of reused water which necessitates greater application volumes, the need for economies of scale in energy-intensive reclamation processes, and perceived quality and safety issues which may suppress willingness to pay (Hidalgo and Irusta, 2005). Table 5 below demonstrates the current pricing structure in Cyprus, which currently reuses nearly all of its reclaimed water.

Table 5: Average water selling rates in Cyprus (EUR/m³)

Application	Reused water	Freshwater
Agriculture (irrigator groups)	0.05	0.15
Agriculture (individuals)	0.07	0.17
For sports	0.15	0.34
Hotels/gardens	0.15	0.34
Pumping from aquifer recharged with treated effluent	0.08	
For overconsumption	50% increase in rates	50% increase in rates

Source: Questionnaire reply from Cyprus

Reused water tariffs in Cyprus range from 33%-44% of freshwater rates, ratios which appear typical for the EU Mediterranean islands (Hidalgo & Irusta, 2005). These price structures represent the imposition of substantial subsidies to reclaimed water supplies to encourage wider uptake, which may be at odds with the need for greater cost recovery in water treatment and management. Although such subsidised price structures have been in place for many years to incentivise take-up, price rates are usually based on intuitive judgements by utilities of the level of willingness to accept (WTA) reclaimed supplies amongst different groups rather than empirical evidence of the price at which users would begin to accept these supplies over conventional freshwater.

In Cyprus, reclaimed water supplies were until recently priced at the same rates as conventional supplies, implying a degree of subsidy. . In recent years, this has begun to change as the price of freshwater has increased whilst reclaimed supplies have been maintained at roughly the same prices – increasing the attractiveness of these supplies to users. Strengthened pollution abatement regulations have also increased the overall capacity of treated effluent supplies. Comparison with uptake levels in 2005 indicates a relatively inelastic demand within the agricultural sector, attributed to distribution and infrastructure constraints, but noticeable elasticity of demand for uses in landscape irrigation (sports, hotels and gardens).

Where elasticity of substitution is high – that is, increasing the price of freshwater has a strong effect on water reuse – it is likely that future rises in freshwater prices would encourage wider reuse. Nonetheless, this may be impractical for some areas owing to social or political concerns. Moreover, some water users are known to have an inelastic water demand in response to freshwater price increases, particularly agricultural users in water-scarce areas where alternative cropping or irrigation techniques are unavailable. Demand for freshwater for many urban uses (especially consumptive) is relatively inelastic, aside from recreational uses such as landscape irrigation (EEA, 2013). This may indicate a greater potential for substitution with reused water in response to price increases, but more detailed data is needed on sector-based consumption of reused water within the EU to establish this.

One interesting factor within the EU is the comparatively low share of industry and non-potable domestic consumption of reused water; such uses are notably higher within many non-EU countries where price support is in place (TYPISA, 2013).

Consumer demand

Evidence from countries with strong reuse of treated effluent points to a high differential against freshwater prices, owing to perceptions of weak demand. It follows that increasing demand and correspondingly higher willingness to pay (WTP) might reduce the price differential over time.

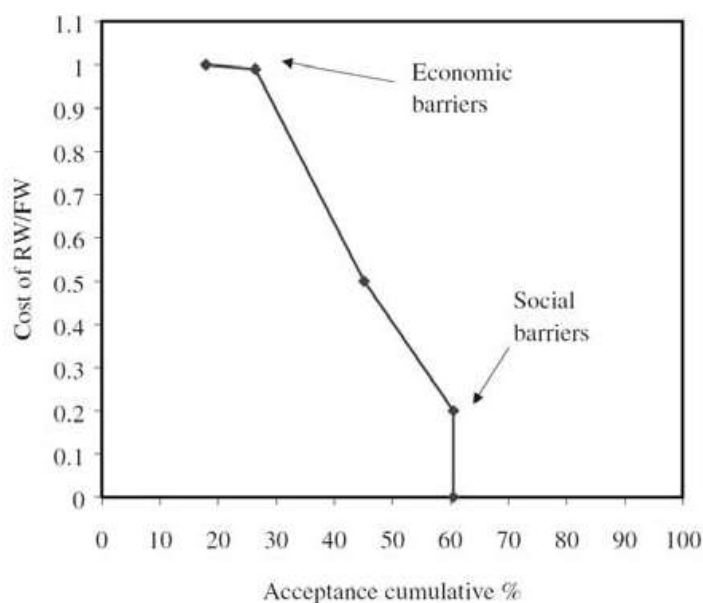
Evidence from North America, for example, suggests that domestic users may be willing to pay a supplement to their existing costs for secondary water reuse as a means of avoiding certain

use restrictions (Dupont, 2013). This is consistent with experiences from the Mediterranean, where abstraction restrictions or taxes have been seen as an important driver of increased demand for reused water as an alternative supply (EUWI, 2007). Although most MS have some form of effluent charges in place, Spain applies an ecotax (*canon del agua*) to domestic and industrial water consumption intended to address both quality and quantitative concerns (EEA,2013).

Another important demand factor is a consistent regulatory regime. The existence (or absence) of different quality standards for reclaimed water across the EU represents a barrier to both agricultural trade and consumer confidence.

Risk perceptions may be highly influential in depressing willingness to pay for reused water. Evidence from several studies (e.g. Menegaki et al, 2007; Tsagarakis & Georgantizis, 2003) suggests that whilst irrigation and agricultural demand is primarily sensitive to price signals and the relative costs of reused water, for other uses (consumption of agricultural products and indirect domestic consumption) demand is sensitive to levels of knowledge regarding the risks and benefits of reclaimed water, although some users demonstrate an almost completely inelastic demand (see Figure 6). This indicates that there is a socially optimal level of reused water uptake, and that better standards and awareness could reduce the need for price differentials against freshwater as applied in Spain and Cyprus. More detailed data analysis of WTP from different users of reclaimed water is necessary to establish the relationship between social acceptance and WTP.

Figure 6: Demand curve for reclaimed water (Tsagarkis & Georgantizis, 2003)



Results from the EU-funded AQUAREC project (AQUAREC, 2006) suggest that reused water prices should rise in the future for several reasons: over time, social acceptance of water reuse and better regulation will increase the willingness to pay for the resource, which in turn will lead to higher prices, and increased water stress levels will further push the prices up. The study modelled potential wastewater reuse capacity to 2025, examining sensitivity to supply and demand-side measures, as well as regulatory objectives (Hochstrat et al, 2005). The model indicates that whilst water-scarce countries such as Spain and Italy have the highest potential, most MS can achieve significantly higher penetration of water reuse through increasing consumer demand. Additionally, outcomes suggest that planned actions linking supply and demand of reused water at the regional or local levels will be necessary to realise increased

reuse of wastewater. This is consistent with best practice outside of the EU, notably in Australia (CSIRO, 2003).

Delivery models

Fragmentation of the water supply and wastewater disposal cycle is a major obstacle for coordination of supply and demand. Responsibilities for both regulating and supplying water services and wastewater treatment and disposal are typically separated, obscuring costs such as water pollution control – which consumes 50% of environmental spending in the EU (EUWI, 2007). Water reuse can be seen as a cost-effective alternative to some point-source pollution abatement measures required under the UWWT Directive, for example (Bixio, et al. 2006).

Separation of water supply and wastewater disposal may act as a constraint on the supply of treated effluent for reuse, both in terms of infrastructure – major investments may be needed to link treatment plants to consumers – and the relative distribution of costs and benefits. For water suppliers, benefits of reuse are largely limited to financial returns (if any), and reducing demand for freshwater may impact on overall investment in water infrastructure (Fatta et al., 2005). For water suppliers, a degree of ‘benefit leakage’ may occur, with few obvious methods for compensation.

The main externalities from water reuse are presented in Table 6 below.

Table 6: Identification of externalities from water reuse (Hernandez et al., 2006)

Groups	Externalities	
	Identification	Unit
Water infrastructure	Avoids constructing facilities to capture and store freshwater	€
	Avoids water purification costs	€
	Avoids constructing pipes and water distribution costs	€
Reuse of pollutants	Reuse of nitrogen in agriculture	kg of N
	Reuse of phosphorous in agriculture	kg of P
	Reuse of sludge in agriculture and gardening	kg
	Reuse of thermal energy	Watt
Uses of the resource	Increases the quantity of water available	m ³
	Guarantees supply in times when there is a shortage	% confidence
	Water quality adapted to different uses is obtained	kg waste
Public Health	Biological risks associated to wastewater reuse	People exposed
	Chemical risks associated to wastewater reuse	People exposed
Environment	Increase in the level of rivers	m ³
	Avoids overexploitation of water-bearing resources	Aquifer level, m
	Avoids water pollution	Waste eliminated, kg
	Allows wetland and river habitat to be recovered	Users
	Increase in pollution due to smell and noise	Number of people
	Decrease in the value of land nearby	€
Education	Raises social awareness of a new water culture	Number of people

Evidence suggests the economic returns on water reuse can significantly outweigh costs, when such externalities and public goods are accounted for (Molinos-Senante et al, 2011; Wilson et al., 2011).

Quantifying these benefits can strengthen the case for reuse schemes and public support, but does not address the practical issue of how to allocate benefits, and in particular up-front costs and risks, within a reuse project. Artificial aquifer recharge is a key example: since beneficiaries could be seen variously as local authorities, operators abstracting water from the aquifer, or end consumers of the water, costs and benefits are difficult to allocate. Greater exchange of best

practice can indicate ways to address this within the constraints of different regulatory and market conditions.

Two best practice examples from Tilburg (Netherlands) and the Flemish coast (Belgium) point to the range of delivery models that can make water reuse economically viable. In Tilburg, a local water service provider and wastewater treatment company formed an ad-hoc water reuse company that has administrative and tax advantages and was able to allocate funds at the lowest interest rate (Bixio et al., 2006).

In Flanders, a single corporate entity assumed responsibility for a range of environmental improvements and utilised economies of scale through a reuse project that split low-quality effluent for discharge, high-quality reclaimed water for aquifer recharge and indirect potable use, and concentrated sludge remediated through crops. This reduced discharge taxes by around 20,000 EUR/year and provided a cost-effective alternative to water transfers (Von Houette & Verbaauwhede, 2012). One key element for the success of this project was the identification of both a supplier and a large-scale consumer of treated freshwater. Unit costs rose by 35% as abstraction declined by 17%, indicating inelastic demand.

Challenges for delivery of water reuse are in many ways analogous to the renewable energy sector, i.e. high investment costs and risks with a long-scale return period. Nonetheless, the macroeconomic case for innovative delivery models is particularly strong in the EU water sector – where a 1 % increase in sector growth can generate up to 20,000 jobs (Alcalde-Sanz et al., 2014).

Coordination of supply and demand through public-private partnerships may be necessary to capitalise on water reuse and to spread the costs and benefits of such schemes through a mix of public and private support and incentive measures. The nature of financing arrangements will depend on the institutional structures of water and wastewater services in different MS, but there is evidence that sharing and communicating best practice examples can drive wider uptake of water reuse (WssTP, 2013).

Future trends in costs and pricing

As demonstrated, costs of reused water are highly sensitive to a number of drivers, particularly economies of scale relating to net demand for water. As such, it is difficult to project future trends in costs and pricing of reused water. Nonetheless, information derived from the baseline examples provides some indication of possible drivers under current policies.

Full cost recovery as required under Article 9 of the WFD would require significant increases (typically in the region of 50%) in freshwater tariffs in a number of MS in the Mediterranean (France, Italy, Spain, Cyprus, Portugal). Assuming our indicative ratio of 33-44% for reused water rates¹⁰⁵, this could increase the relative attractiveness of reused water in these countries whilst strengthening the economic viability of reused water. Significantly, these countries are also the strongest (or most promising) markets for reused water at present. At present, 37% of wastewater reuse in southern Europe is utilised in urban or environmental applications (Sato et al., 2013), and levels of cost recovery have been significantly higher than for agricultural applications.

¹⁰⁵ Reused water tariffs in Cyprus range from 33%-44% of freshwater rates, ratios which appear typical for the Mediterranean (Hidalgo & Irusta, 2005)

No EU wide projections could be found for overall water prices in future, perhaps reflecting the variations in pricing structures between MS and water uses. However, in the UK, where capital and O&M cost recovery is well-established through privatised utility providers, retail costs of freshwater are nonetheless expected to increase by **2-3% per annum** up to 2020, based on changes in input price inflation as well as scope for productivity improvement (First Economics, 2013). The latter may have particular importance in the context of water reuse, given that significant public and private research and development spending is ongoing in reuse technologies. This may drive down relative costs for reused water and increase the efficiency of reuse schemes.

A further uncertainty is the requirement of the WFD that cost recovery also includes external costs relating to water, such as environmental or resource depletion costs. External costs relating to water are methodologically difficult to determine at present, and rarely applied in EU MS. Some water companies estimate environmental/external costs in the region of 20-25% of financial costs, but it is questionable if such an across-the-board approach can truly reflect locally or regionally-varying factors influencing the cost of water supply (Berbel, et al. 2007).

Rising environmental costs, i.e. for wastewater treatment, will assume an increasing importance as MS move towards enforcement of the polluter-pays principle within the WFD, and stronger enforcement of the UWWTD. Stricter Environmental Quality Standards and monitoring processes may increase water prices and incentivise greater uptake of decentralised wastewater treatment solutions.

Although more than 80% of wastewater in the EU is currently treated, this percentage is expected to rise as a result of compliance improvements in the EU-12. Experience from existing reuse schemes (such as in Malta) indicates that an increase in the supply of treated wastewater has facilitated increased demand for water reuse. Such cases also highlight the economic value of treated effluent with high nitrogen nutrient content to irrigators: this can act as an incentive for operators of wastewater treatment plants to invest in water reuse infrastructure rather than developing nutrient removal treatment installations.

Energy demand will be a major driver of future costs and prices. Electricity prices in the EU are significantly higher than in other regions, a differential that is expected to increase (Arcadis, 2012). As there are many situations where production of recycled water uses less energy than alternative water supply options (such as desalination or water transfers), costs of using reused water may become lower than alternatives; for example, pumping or transport of groundwater for irrigation purposes, where energy costs would subsequently increase. The energy intensity of water reuse (with conventional treatment) is in the range 0.8-1.2 kWh/m³, vs. 2.3-4 kWh/m³ for seawater desalination using reverse osmosis; this compares to an energy intensity of 0.1-0.3 kWh/m³ for treatment and distribution of conventional surface water sources (Pearce, 2007).

Investment costs will vary significantly between MS. Investment costs vary from 45-75% of the total cost of a water reuse project (Asano et al., 1998). The volume of these costs is contingent on a number of factors, such as existing water treatment infrastructure (France, for example, relies heavily on aerated lagoons for wastewater treatment, which increases the capital costs of reuse projects). Access to domestic technology can significantly influence unit costs, so MS such as Spain with strong domestic providers of water reuse technology may be able to develop reuse projects with lower capital, operations and maintenance costs.

Cost effectiveness of reuse schemes will increase with greater demand. Existing reuse schemes have demonstrated a strong link between volumetric demand for reused water and

unit costs: the more water utilised, the more cost-effective the project. As large water users, irrigators would appear best-placed to make use of reused water, although heavy subsidies to freshwater in the irrigation sector appear to counteract any economies of scale for reuse schemes. Applications in industrial and urban settings will increasingly offer the economies of scale necessary to reach viable unit costs. Experience from Spain points to a flow of 10,000-20,000 'inhabitant-equivalents' to make capital expenditure on reuse schemes viable (AQUAREC, 2006). Southern and eastern European MS are projected to have the highest growth in potable water demand in the coming decade, in line with growth in per-capita GDP (EEA, 2009). Moreover, in the future, it could become more and more cost efficient to reuse phosphorus present in the wastewater, as world market prices for this element are increasing and some WWTPs are starting to recover it.

Therefore, while no projections could be found for the future demand or price of reused water, the above trends suggest that demand can be expected to increase in future years, increasing the price of re-used water. This should in turn help to stimulate increased investment, yielding economies of scale and reducing unit costs. The overall effect on the price of reused water in the long term will depend on the balance of these demand and supply side drivers, and is therefore difficult to predict.

2.8.2.2 *Avoided costs related to water scarcity and droughts*

As a means to reduce water scarcity and droughts, water reuse solutions contribute to **reducing the associated costs of economic damages, reducing the constraints on economic development due to water shortages and reducing the economic consequences of uncertainty about water availability** – a potential obstacle to investment decisions. In the absence of policy intervention, these costs can be expected to increase substantially in some regions.

Recent droughts have undoubtedly resulted in increasing and significant impacts on the economy and on natural resources. As an illustration, the overall impacts on the economy due to the 2003 drought have been estimated at a minimum of EUR 8.7 billion (mainly concerning Mediterranean countries, France and the UK), measured as the estimated losses directly resulting from the drought (EC, 2007). Direct effects of droughts, such as damage to agriculture and infrastructure, are more obvious, but indirect effects, such as a reluctance to invest in an at-risk area, can also have a serious economic impact. A 1% increase in the area affected by drought can slow a country's gross domestic product (GDP) growth by 2.7% per year (Brown et al., 2013).

In Catalonia, Spain, a simulation of the macroeconomic impact of water restrictions to the Catalan economy for the year 2001 showed that restrictions on non-priority water uses following a drought warning would have led to a loss of gross added-value of about EUR 1.196bn (0.97% of Catalonia's GDP), while extended restrictions in the case of an extreme drought would have caused a loss of EUR 8.079bn, representing 6.52% of the GDP (Gonzalez et al., 2009).

Where water resources are scarce or threatened by droughts, the supply of reclaimed water to agriculture or industry can result in a **more secure supply of conventional sources to domestic users**. This is not only apparent in high risk areas in southern Europe, but also a

driver for supply of recycled water to industrial users in MS not subject to significant water stress, e.g. the energy sector in eastern England¹⁰⁶ (IEEP, 2012) and the food industry in DK.

Agriculture is by far the largest water consumer. Modern agriculture in water stressed regions depends on irrigation to achieve its production contract and food security, as irrigation can increase productivity by up to 50% (EUREAU, 2009a).

According to WssTP, maintenance of attractive areas in **tourist regions** (hotel gardens, golf courses, surface water bodies) is a clear benefit from water reuse and added value from reuse applications can also accrue in support of major economic activities in a region. In tourist regions of Cyprus, Portugal, France and Spain, water reuse is currently applied to ensure reliable water supply to leisure facilities such as golf courses.

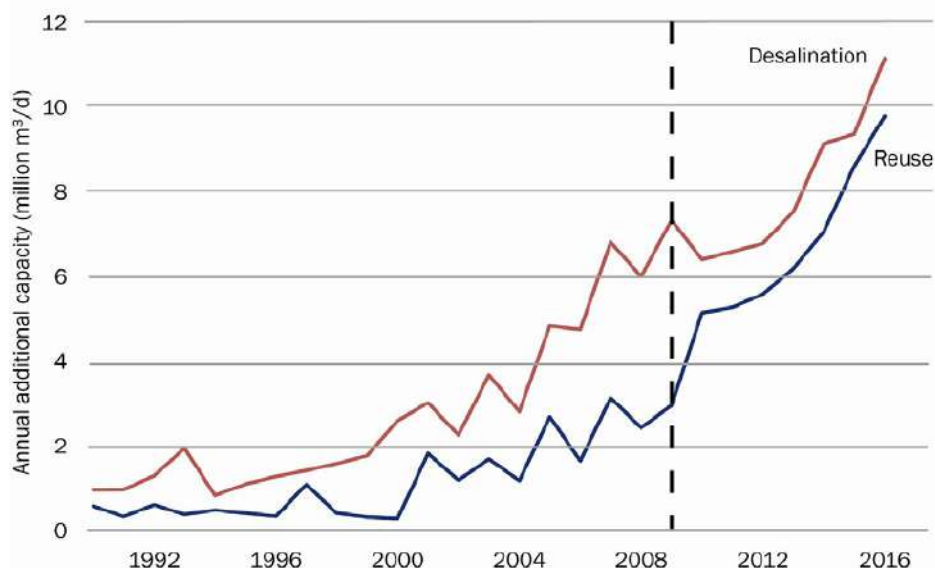
The economic damages associated with water scarcity and droughts are analysed in further details in the Blueprint Impact Assessment (EC, 2012).

2.8.2.3 *Benefits for the water reuse industry, EU competitiveness and innovation potential*

There is a rapidly growing world water market, which is estimated to be as large as 1 trillion Euros by 2020. By seizing **new and significant market opportunities**, Europe can increasingly become a global market leader in water-related innovation and technology (EC, 2012).

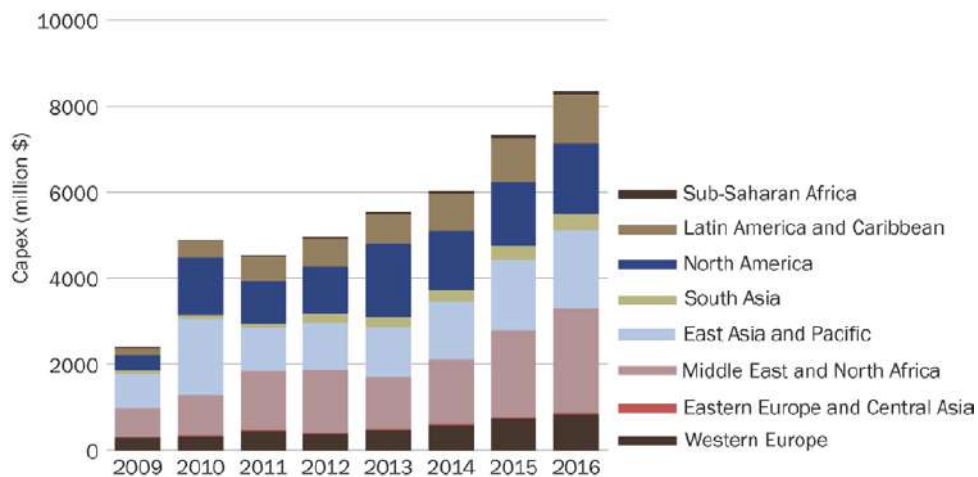
The figures below show projection of annual additional capacity of desalination and water re-use worldwide and regional growth in tertiary or better re-use capex market, respectively. Both figures are quoted from 'Municipal Water Reuse Markets 2010', Global Water Intelligence (GWI, 2010a).

Figure 7: Annual additional tertiary and advanced capacity worldwide: Desalination versus Reuse



¹⁰⁶ <http://www.waternunc.com/gb/angliw08.htm> (accessed 08.09.2014)

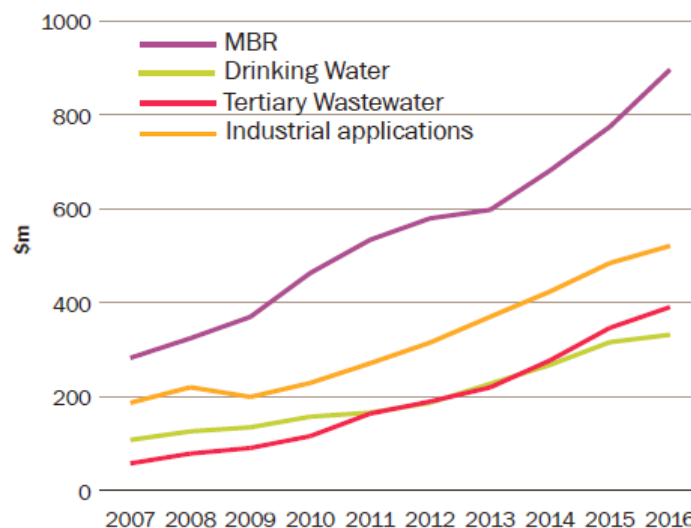
Figure 8: Regional Growth in Tertiary or Better Re-use Capex, 2009 – 2016 (million US \$)



According to Global Water Intelligence (GWI, 2010a), the **global market for water re-use is on the verge of major expansion** and, going forward is expected to outpace desalination. Figure 14 demonstrates the anticipated rate of growth. Between 2009 and 2016 capital expenditure on advanced water re-use is expected to have grown at a compound annual rate of 19.5% as the global installed capacity of high quality water re-use plants grows from 28 Mm³/d to 79 Mm³/d.

The figure below shows the market forecast to 2016 for low-pressure membrane. The steep increase in Membrane Bioreactor (MBR) is seemingly due to the growing demand for water re-use, although the membrane has broader application than re-use alone. The development of those key technologies is expected to contribute to the steady growth in water re-use market.

Figure 9: Market Forecast to 2016 for Low-pressure Membrane (million US\$)



The EU water reuse sector is maturing both technologically and commercially, albeit at a slow rate. Where ten years ago the number of full scale operating schemes was limited there is now a considerable number of live projects of varying type and scale (WssTP, 2013). The WssTP has identified a **huge eco-innovation potential** in terms of technologies and services around water recycling in industry, agriculture and urban water systems (WssTP, 2013). Water reuse practice for agriculture and industry is one of the fastest growing applications internationally (approximately three times the growth of desalination) (EUREAU, 2004).

Given the importance of the water industry sector in the EU, the past and current spread of water reuse technologies in the EU and worldwide has been a driver for the **competitiveness of this industry sector**, and this situation is expected to continue over the next 10 years. Water supply and management sectors already represent 32% of EU eco-industries value added and EU companies hold more than 25 % of the world market share in water management (EU, 2011).

Water reuse is also a driver of competitiveness for many other EU industries outside the water sector. According to WssTP, a **greener image** is, for a lot of industries, an important benefit of water reuse. With the development of **product water footprints**, the use of recycled water instead of freshwater can be a key argument which can be put forward in addition to water saving efforts. In some sectors however, like food and beverages, the use of reclaimed water can lead to negative images e.g. in relation to health and safety (WssTP, 2013).

2.8.2.4 Internal market

The heterogeneity of national requirements or recommendations concerning the management of health and environmental risks associated with water reuse raises questions with regard to **internal trade of agricultural products irrigated with reclaimed water**. This issue has already been discussed in Sections 2.6 and 2.7.

2.8.2.5 SMEs and microenterprises

One of the sectors that is the most directly impacted by current water reuse practices is the **agricultural sector**, which encompasses a wide number of microenterprises (i.e. farms). Water reuse provides economic benefits to farms, by increasing water availability for irrigation.

Although water required for agricultural production declined substantially in most Southern MS following the 1992 reform of the Common Agricultural Policy (CAP) (which led to large-scale reductions in production) and more efficient irrigation methods, recent years have seen demand begin to increase again within these MS, as well as in newer (Eastern) MS (Arcadis, 2012; TYPASA, 2013). Under a scenario of increasing scarcity due to climate change, as well as regulatory changes under the WFD, financial costs of securing freshwater supplies are likely to increase for agricultural businesses, although few agricultural SMEs bear the cost of wastewater treatment directly.

The **tourism sector**, which includes a high number of microenterprises, also benefits from the 'greener image' associated with the reuse of water. For example, the reuse of wastewater is a way to counterbalance the environmentally controversial development of golf courses in water scarce areas (Salgot et al., 2012). Many tourism operators in water-scarce island areas (for example, many Greek islands and Cyprus) make use of reclaimed water for landscape irrigation, albeit at highly subsidised rates.

Industrial water users are also major volumetric consumers of water for processes as diverse as mixing, cooling, boiler feed and plant wash-down as well as for washrooms and other sanitary uses. Major consumers of water and producers of wastewater include the chemical sector, paper and pulp production sector, beverage sector, textile sector and aggregates sector. Of these, the paper and pulp sector cannot generally be considered as an SME sector because of the larger scale of operations within this sector. The majority of industrial SMEs are likely to source wastewater treatment services from an external supplier. As such, restrictions associated with WFD compliance and other water regulations are likely to be represented through increasing costs for the discharge of industrial effluent as well as other administrative

requirements (such as information to be provided to water service providers on effluent content to ensure compliance with emission limit values). Nonetheless, these financial costs are likely to be significant, and will place a greater burden on SMEs than on larger production sites or enterprises.

2.8.3 Social aspects

2.8.3.1 *Public and occupational health*

Public health

Risks to public health are one of the key concerns associated with the reuse of reclaimed water. These risks may occur through **direct or indirect exposure of the public with microbiological agents (pathogens) or chemical substances** that are usually present or may be present in reclaimed water.

Health impacts of water reuse depend upon the wastewater origin, the conditions imposed on the treatment and the subsequent use of the reclaimed water.

The composition of reclaimed water may vary depending on the origin of the collected wastewater, season, health status of the population and treatment applied (ANSES, 2012). Many pathogens can survive for long periods of time in soil or on crop surfaces to be transmitted to humans or animals. Pathogens which are the most resistant in the environment are helminth eggs, which in some cases can survive for several years in the soil.

There are different possible exposure pathways, including in particular:

- Ingestion of reclaimed water or inhalation of droplets of reclaimed water, especially when the water is used for urban or recreational purposes;
- Ingestion of food products harvested from crops irrigated with reclaimed water;
- Ingestion of meat from animals grazing on pastures irrigated with reclaimed water or fed with forage crops irrigated with reclaimed water.

Human health and environmental risks associated with reclaimed water reuse are described in publications such as Deliverable D15 of the AQUAREC project (Salgot et al., 2006) or the WHO guidelines (WHO, 2006), with additional examples of exposure pathways for potential chemical and biological contaminants. According to the WHO, for the reuse of water in agriculture, the greatest health risks are associated with crops that are eaten raw (e.g. salad crops), especially root crops (e.g. radish, onion) or crops that grow close to the soil (e.g. lettuce, zucchini) (WHO, 2006).

However, there are **very few health risk quantification studies and epidemiological studies on the reuse of reclaimed water**; most of epidemiological results concern the reuse of raw sewage (where the contamination risks are much higher). **The literature, however, does not report cases of human diseases caused by reclaimed water in the EU.** This is confirmed by the experience of Cyprus, a Member State with a long experience of reusing water for irrigation and groundwater recharge, and where almost all the treated effluents are now being reused.

The **EU-funded SAFIR project** (2006-2010) assessed, among other aspects, the potential effects on human health of eating vegetables irrigated with reclaimed water (SAFIR, 2009).

Their results show that the microbiological health risks as a result of eating tomatoes or potatoes irrigated with recycled water produced by the SAFIR project were minimal¹⁰⁷. However, farmers should be aware that accidental ingestion of soil irrigated with recycled water could pose a health risk. The studies were undertaken on farms in Crete, Italy and Serbia where potatoes and tomatoes were either surface irrigated or subsurface irrigated with reclaimed water. Water, soil and produce samples were analysed for *E. coli*. In all cases, the concentration of these infective agents on the tomatoes and potatoes was negligible, so consumption of these vegetables could be considered safe.

Several studies have been conducted in **Cyprus** in order to assess the potential impacts of irrigation with treated municipal wastewater on crops¹⁰⁸. Research results concerning the long-term wastewater irrigation of forage and citrus revealed no impacts on both soil physicochemical properties and heavy metal content, as well as on agricultural produce heavy metal content. Research results concerning wastewater irrigation of tomato crops showed no accumulation of heavy metals in tomatoes, whereas total coliforms and fecal coliforms were not quantified in both tomato flesh and peel, and *E. coli*, *Salmonella* spp and *Listeria* spp were not detected in tomato homogenates. Research on pharmaceutical compounds detected traces of these compounds in treated effluent but further research is going on to assess whether they are being taken up by plants under field conditions.

In **Greece**, the Thessaloniki WWTP effluent reuse project has been built upon the findings of long (more than 10 years) experimental work carried out by the Land Reclamation Institute of the National Agricultural Research Foundation (Ilias, 2014). During this experimental work, the appropriate practices to irrigate sugar beet, cotton, corn and rice, which are the main crops of the area, were investigated. Two water qualities, treated wastewater and freshwater (control), were tested in relation to the effects on crop production, soil properties, irrigation equipment and health risks. With regard to health risks, no significant risks were identified by the survey, because the pathogenic microorganisms in the chlorinated effluent were well within the limits, according to various health criteria. It was concluded that both the level furrows with blocked ends and the drip irrigation system satisfactorily protected the farmers from being in contact with the water.

In France, several reviews of public health risks have been carried out as part of the development of the national legislation on the reuse of treated urban wastewater. One of these reviews concluded that the health risk associated with reclaimed water for irrigation was **comparable or lower than the risk associated with sewage sludge spreading in agriculture** where such spreading is conducted in compliance with the regulation (AFSSA, 2008).

Further examples of health risk assessments are presented in Box 4 below.

¹⁰⁷ In this project, two advanced wastewater treatment systems were used (a compact biological-mechanical technology for decentralised treatment of municipal water, and a new modular system developed by the project team to treat less polluted water)

¹⁰⁸ Research works carried out by the University of Cyprus, presented during the CIS PoM working group meeting of 25/03/14

Quantitative microbial risk assessment models for consumption of raw vegetables irrigated with reclaimed water (Hamilton et al., 2006)

Quantitative Microbial Risk Assessment was used to estimate the annual risk of enteric virus infections associated with consuming raw vegetables that have been grown with non-disinfected secondary reclaimed water (in Australia). For all combinations of crop types, effluent qualities, and viral decay rates considered, the annual risk of infection decreases with the number of days since the last irrigation event; ranging from 10^{-3} to 10^{-1} when reclaimed-water irrigation ceased 1 day before harvest and from 10^{-9} to 10^{-3} when it ceased 2 weeks before harvest. When fixing a decay coefficient, it was observed that – for all combinations of type of crops and effluent qualities – the more aggressive decay coefficient led to annual risks of infection that satisfied the commonly propounded benchmark of $\leq 10^{-4}$ provided that 14 days had passed since irrigation with reclaimed water. This benchmark was not attained for any combination of crop and water quality when this withholding period was 1 day. When using the lower decay rate, broccoli and cucumber are the only crops that satisfy the 10^{-4} standard for all water qualities after a 14-day withholding period.

Quantifying the effect of Managed Aquifer Recharge (MAR) on the microbiological human health risks of irrigating crops with recycled water (Ayuso-Gabella et al., 2011)

Quantitative Microbial Risk Assessment was used to assess the human health risks from irrigation using reclaimed water and to evaluate the reduction in risk where MAR is used for irrigation management. Four MAR sites (in Israel, Italy, Australia and Spain) that use reclaimed water for crop and/or park irrigation were evaluated, and the risk to human health was quantified in terms of DALYs (Disability Adjusted Life Years). The results indicated that median risks for all scenarios and pathogens evaluated (viral, bacterial and protozoan pathogens) were acceptable ($<10^{-6}$ DALYs), with the exception of risks from accidental aerosol ingestion and bacterial pathogens at the Italian site. MAR was found to be one of the most important treatment barriers, and hence a useful tool for recycled water irrigation management.

Reuse of treated wastewater for sprinkler irrigation of crops and green spaces (ANSES, 2012)

The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) investigated health risks associated with the reuse of treated urban wastewater for sprinkler irrigation of crops and green spaces, for different categories of population, via respiratory tracts and mucocutaneous exposure. The aim was to assess whether the scope of the French legislation on water reuse could be extended with regard to sprinkler irrigation (at the moment, sprinkler irrigation is only authorised for experimental purposes). However, the epidemiological data found in the literature were insufficient to conclude whether the presence of microorganisms in the reclaimed water represents a risk for human health. The ANSES put forward a number of measures to limit human exposure during sprinkler operations; these measures could be implemented to replace the experimental study prescribed by the current legislation.

Emerging pollutants, such as pharmaceutical products and their metabolites, personal care products, household chemicals, food additives, etc. are a growing environmental and health concern that is also relevant to water reuse. Although present in very small concentrations in urban wastewater, there are concerns about their long-term effects on human health. At the moment, however, there is no scientific consensus on the actual level of risks associated with these various substances. Secondary treatment of urban wastewater does not efficiently remove most of these pollutants, but, according to water treatment experts, more advanced (and expensive) treatment technologies are currently available to remove them. For example, with regard to pharmaceutical residues, the EU-funded RECLAIM WATER¹⁰⁹ project found that advanced water treatment technology with ultrafiltration and reverse osmosis produces water of drinking quality that is not a source of diffusion of antibiotic resistance gene in the environment.

¹⁰⁹ <http://www.reclaim-water.org/>. The project aimed to provide effective technologies to monitor and mitigate emerging risks posed by chemical contaminants and pathogens in reclaimed wastewater streams used for groundwater recharge.

Occupational health

Different types of workers may be exposed to reclaimed water and to the possible microbiological and chemical contaminants mentioned in the above section: **farmers**, workers in the **reclaimed water industry**, workers in **industries where reclaimed water is used**, **workers involved in urban and recreational applications** of water reuse, etc. While the workers may be exposed to potential contaminants during longer periods than the public, the risks are not necessarily higher due to better awareness and the implementation of risk control measures (e.g. protective equipment). The literature does not report cases of occupational diseases caused by exposure to reclaimed water.

2.8.3.2 Employment

As a means of increasing water availability, water reuse provides further economic security to agricultural producers, which translate into social benefits. This enables jobs to be secured, providing benefits to local communities (EC, 2012). For example, in Clermont-Ferrand (France) and San Roco (Italy), 60 and 35 **agricultural jobs** were secured thanks to water reuse projects respectively; both projects have enabled a dynamic agricultural activity to be maintained in regions where crops were endangered due to a lack of available water (Clermont-Ferrand) or the use of untreated wastewater (San Roco) (AFD, 2011). In the Almeria province, Spain, the use of reclaimed water for farmland irrigation led to increased crop production and thus 1 million working hours are offered during the crop season (Thomas and Durham, 2003).

In MS from Southern Europe (e.g. Spain, Cyprus, Greece), **tourism** is a major economic sector, strongly contributing to the economy and to employment. In those water-scarce countries, a reliable supply of water services is a critical input to foster advances in tourism activities (EC, 2013c). Therefore, water reuse has an indirect influence on the development of tourism, by allowing the development of water-related activities and thus creating jobs. In Spain, for example, secure supply of water for leisure activities (e.g. irrigation of golf courses) is important for local communities and employment (Anderson, 2003).

The expansion of water reuse practices to date has provided employment benefits in the **water industry sector**, with qualified jobs in the development, operation and maintenance of wastewater treatment and reclaimed water solutions as well as in R&D, taking into account the innovation potential of this area. Employment benefits also extend to suppliers of systems, equipment and chemicals for wastewater treatment and reuse. Waste water treatment and water supply sectors represent between 22 and 34% of EU eco-industries employment¹¹⁰ (depending on the methodologies used) (ECORYS, 2012) and have a growing-potential which is well spread among all EU regions. A 1 % increase of the rate of growth of the water industry in Europe could create between 10,000 and 20,000 new jobs (EC, 2012).

2.8.3.3 Public acceptance

The reuse of wastewater raises issues in terms of public acceptance, especially for drinking water production applications. The type of application for which water is reused is an important factor for public acceptance. Public acceptance decreases when public health is at stake or when there is a risk of contact or ingestion of reclaimed water. For instance, public acceptance

¹¹⁰ Which themselves employ around 3.4 million people, i.e. around 1.5% of all Europeans in employment, more than in car manufacturing, chemicals or textiles.

for reusing water to irrigate crops that are intended to be eaten or to wash clothes can be low while reusing water for bioenergy cropping will not cause serious public concerns (IEEP et al., 2012).

The survey conducted as part of the AQUAREC project (2006) revealed that, in the view of some public administrations and of the population, treated wastewater still remains basically wastewater. Furthermore, according to water industry experts, it is not widely known that in many urban and semi-urban areas in Europe surface or ground waters have bacterial quality worse than that of a secondary-treated wastewater, and that some agricultural areas are irrigated with self-abstracted water whose quality is lower than secondary-treated water. It is not widely known either that, in many urbanized catchments, the water cycles actually include indirect, unplanned and uncontrolled reuse of - sometimes even untreated - wastewater (Bixio et al., 2006).

Public acceptance is difficult to achieve as long as citizens are not fully **aware of the need** to reuse treated wastewater and consider it an efficient solution to address water scarcity and to reserve high quality water supplies for drinking water purposes. The first stage of acceptance of the use of reclaimed water is the acceptance by the community of the need. In this case, the use of reclaimed water becomes a solution to a problem and this, in turn, is an important driver of public perception (UK Water Research Industry, 2003).

Public acceptance also strongly relies on the **understanding of the local water cycle**. An important consideration is the question of when does wastewater cease to become wastewater and become just another water resource (UK Water Research Industry, 2003). In this respect, separating the reclamation phase and the application phase by dilution and storage either in a reservoir or in groundwater may be an important step in achieving acceptance, particularly when retention can be measured in weeks or months rather than days (Strang, 2004). This approach has been used with considerable success in a number of circumstances where reclaimed water has been used to directly supplement drinking water sources in Singapore and the UK (Walker, 2001). A study was conducted in 2002 by Hills et al. in order to evaluate the customer perception of the “Watercycle” recycling scheme of the London Millenium Dome (now called the O2 Arena). The use of reclaimed water was explained in the venue thanks to signage in the washrooms and a Watercycle exhibit. The study showed, notably, that the acceptability of reclaimed water systems was significantly enhanced in the individuals who had seen the signage in the washrooms or the Watercycle Exhibit. A recent US-based study aimed to assess whether prior knowledge of unplanned potable reuse affects acceptance of planned potable reuse (McPherson and Snyder, 2011). It revealed that users’ perception of reclaimed water can improve significantly once they receive information about the holistic water cycle and the existence of unplanned potable reuse. It also revealed that the terminology continues to have a strong influence on the level of acceptability (e.g. ‘purified water’ much better perceived than ‘treated wastewater’) and that more information on monitoring and testing is needed to increase trust.

Public applications of water reuse can be instrumental in building support for reuse in general, with many state or national reuse plans utilising environmental applications as the first stage in a tiered approach to addressing public perceptions and widening applications (Lazarova, 2013).

Public acceptance increases with a higher degree of **stakeholder involvement**. In this respect, the public, the reclaimed water provider and their customers are all stakeholders along with environmental groups, suppliers of wastewater and drinking water services and regulators (UK Water Research Industry, 2003). In the city of San Diego in California, stakeholder involvement was identified as a success factor in the change of public opinion from opposition to

acceptance. A study carried out in the Segura River Basin, Spain, showed that the acceptability of using reclaimed water for agricultural purposes increases when the population is made aware of the cost of traditional supplies and the savings that can be made from reusing water (Alcon et al., 2010). However, public awareness about the allocation of costs and benefits can reduce public acceptance, when this allocation does not appear as socially just. There are many examples where people paying for the production of reclaimed water are not those who benefit directly from it. For instance, such acceptability issues have been reported in the South-East of France, where cities are paying for water benefiting to the countryside¹¹¹.

In 2012, a survey of public perceptions of recycled water was conducted among visitors to the London Olympic Park, which includes several venues supplied with non-potable recycled water (Smith et al., 2013). Results showed a very high level of support for using non-potable recycled water, both in public venues and in homes. While this study did not consider receptivity to any potable reuse schemes, which are far more likely to raise objections, it does suggest that there may be a growing maturity in the UK's general public dialogue around water reuse.

In France, a good level of acceptability with regard to water reuse has also been observed during a recent survey (CGDD, 2014): a majority of the French population (68%) agrees to consume fruits and vegetables irrigated with reclaimed water. However, the survey showed that less than half of the population (45%) would accept domestic supply of drinking water produced from reclaimed water. A perception survey was also conducted in the context of the Clermont reuse scheme (crops irrigation), showing high acceptability of the nearby inhabitants¹¹¹. The French population is currently being consulted in the context of the ISO work on irrigation with reclaimed water.

In Italy and Greece, stakeholders reported that public acceptance was a key barrier to the wider uptake of water reuse for agricultural purposes¹¹². In Italy it has also been reported farmers producing “high quality food” or “traditional food” are worried about the reaction of consumers to the reuse of water in these productions¹¹³.

According to WSSTP (2013), growing confidence in technologies such as ultrafiltration, reverse osmosis, membrane bioreactors, and ultra-violet disinfection, has also reduced public health concerns about reuse.

2.8.3.4 Governance and participation

Many developers are aware that stakeholder participation is a key success factor for the development and efficient operation of water reuse schemes. This can be illustrated by the results of the following survey examples:

- Birkhoff (2003) analysed public participation in water reuse projects in Georgia, Texas, and California. She found that substantively better decisions emerged when diverse interests, knowledge, and expertise were involved in the decision-making process. Conversely, when stakeholders were not fully involved in framing, analysing, generating, and implementing solutions to complex public problems, they sought other ways of articulating and meeting their interests, hampering the decision process.

¹¹¹ Verbal information from the French Ministry of Environment

¹¹² Source: Questionnaire replies from IT and ES and verbal information from national stakeholders.

¹¹³ Source: Italian Environment Ministry

- Furthermore, research was undertaken at four case study sites in Australia and the United States and aimed at identifying the social and management issues important to the success of water reuse projects (Marks, 2005). The cross-national findings show that an important success factor is the institutional and structural arrangements that inform and involve the public and provide transparent governance.

In order to build trust and get support, developers and local authorities therefore have to initiate stakeholder awareness raising actions, consultation and collaboration activities during the development of new water reuse schemes. In most cases, the development of water reuse projects is thus an opportunity to enhance good governance practices and public participation.

3. Policy options

Policy options identified to address the barriers associated with the reuse of water in the EU are described in this chapter. These policy options have been identified on the basis of the evidence analysed as part of this study and presented in Chapter 2, as well as feedback received from the stakeholders and results of the public consultation, while taking into account the subsidiarity and proportionality principles. First, the overall and detailed objectives of future policy action are defined, based on the problem definition. Second, a list of policy measures that could support the achievement of these objectives is proposed. The analysis highlights policy measures warranting further investigation and those which can be excluded from the analysis, based on preliminary screening. Individual policy measures are then grouped into policy options corresponding to different levels of ambition. The rationale for each policy option is explained in this chapter, as well as its main objective and the specific problems it could address.

3.1 Policy objectives

3.1.1 General policy objective

In order to address the problem drivers identified in Section 2.6, EU action should stimulate the reuse of reclaimed water as a means of providing an alternative water supply and so reduce the pressure on surface and ground water sources, while providing a stable supply to users in times of scarcity and drought. This means **achieving a higher uptake of appropriate water reuse solutions, where it proves cost effective** (taking into consideration the wide range of potential costs and benefits), **while ensuring the safety of reuse practices** (i.e. providing a high level of confidence in the management of human health and environmental risks associated with reuse practices) and **avoiding potential internal trade barriers** for food products irrigated with reclaimed water.

3.1.2 Specific policy objectives

The following specific policy objectives are defined:

- O1 / Promote an increased use of economic instruments to make water reuse schemes more economically attractive;
- O2 / Build trust, credibility and confidence in the quality of reclaimed water among the general public;
- O3 / Provide clarity on how to manage public health and environmental risks of water reuse projects in the EU;
- O4 / Promote water reuse as an integral part of integrated water management;
- O5 / Increase knowledge on the benefits of water reuse among the various stakeholders;

- O6 / Avoid potential internal trade barriers for agricultural products irrigated with reclaimed water;
- O7 / Create a level playing field for reclaimed water users across the EU; and
- O8 / Improve scientific knowledge and technical expertise in the field of water reuse.

The links between these specific policy objectives and the problem drivers are presented in Table 7 below.

Table 7: Specific policy objectives and their links with the problem drivers

Specific policy objectives	Problem drivers addressed by the objectives									
	Inadequate water pricing and business models	Insufficient control over freshwater abstraction*	Stakeholders unaware of the range of benefits	Lack of public acceptance	Lack of confidence in the safety of water reuse practices	Unclear regulatory framework	Too stringent standards for the intended use	Reuse not seen as a component of integrated water management	Fear of potential barriers (food products)	Technical and scientific challenges
O1 / Promote an increased use of economic instruments to make water reuse schemes more economically attractive	X	Already addressed by other EU policy initiatives, hence no specific objective defined here								
O2 / Build trust, credibility and confidence in the quality of reclaimed water among the general public			X	X	X			X	X	
O3 / Provide clarity on how to manage public health and environmental risks of water reuse projects in the EU				X	X	X	X		X	
O4 / Promote water reuse as an integral part of integrated water management								X		
O5 / Increase knowledge on the benefits of water reuse among the various stakeholders			X	X	X			X		
O6 / Avoid potential internal trade barriers for agricultural products irrigated with reclaimed water									X	
O7 / Create a level playing field for reclaimed water users across the EU						X	X		X	
O8 / Improve scientific knowledge and technical expertise in the field of water reuse										X

3.2 Possible measures identified

Several possible policy measures have been identified which may achieve (in part or fully) the set of objectives defined above (see Table 8). The list of policy measures presented in Table 8 below has been drawn up based on: the problem analysis (see Sections 2.5 and 2.6), a review of policy measures in EU and non-EU countries going beyond the current EU policy framework, the stakeholders' consultation and the results of the public consultation.

While the table provides a relatively broad range of possible measures, some of them are considered as being less relevant for the purposes of the present study. The table below provides explanations on why these measures are not retained for further assessment.

Table 8: List of possible EU policy measures and their links with the specific policy objectives

Possible EU policy measures	Related specific objectives	Comments
Increase the level of enforcement of WFD requirements concerning water pricing (Art. 9) and freshwater abstraction (Art. 11)	O1	The report 'Assessment of cost recovery through water pricing' prepared by the EEA provides a number of policy recommendations in this regard (EEA, 2013). While this is a key policy measure to address the economic barriers associated with water reuse, the enforcement of WFD requirements on water pricing and abstraction permits goes well beyond the scope of water reuse and it is a key action area identified by the Blueprint; therefore it is not further investigated as part of the present study.
Develop EU guidelines to support the design and implementation of the right price structure and level for water reuse - these guidelines would include recommendations in order to address market failures that currently limit the uptake of water reuse solutions	O1, O5, O7	
Organise awareness raising campaigns, develop awareness raising tools and disseminate information on the various benefits of water reuse, among all key stakeholders	O2, O4, O5, O6	
Develop a harmonised set of definitions and Key Performance Indicators (KPIs) for the reporting of water reuse data across the MS	O2	
Develop a good practice reference document on water reuse, resulting from a knowledge exchange between MS and other stakeholders	O2, O3, O4, O5, O6, O7	
Improve implementation and enforcement of the WFD with regard to integrated water management and better governance (e.g. cooperation between water supply and sanitation stakeholders)	O4	While this is a key policy measure to address the governance-related barriers associated with water reuse, the enforcement of WFD requirements on integrated water management goes well beyond the scope of water reuse and it is a key action area identified by the Blueprint; therefore it is not further investigated as part of the present study.
Include water reuse - other than internal recycling - as key aspect to be considered in the definition of Best Available Techniques (BAT), so that it is taken into account in the development of future Best Available Techniques Reference Documents (BREFs) and progressively integrated into the provisions of new permits issued under the Industrial Emissions Directive (IED). This could cover both the use of externally produced reclaimed water by an industrial plant and the production of reclaimed water by an industrial plant for external uses.	O4, O5	There are some doubts about the feasibility of including such considerations within the scope of BAT, as it does not directly affect the environmental emissions of an industrial plant (in the case of production of reclaimed water for external uses) and is very much dependent on the location of the plant (in the case of supply with externally produced reclaimed water). Hence this potential measure has not been further investigated.

Possible EU policy measures	Related specific objectives	Comments
Develop guidance on the use of European Structural and Investment Funds (ESIF) supporting projects to comply with the UWWTD.	O1, O4	As many of the projects implemented to comply with the UWWTD (e.g. construction or upgrade of WWTPs) offer potential for water reuse, EU funding could be conditioned by an assessment of water reuse options. However, the feasibility of this policy measure seems limited at present, hence it has not been taken forward.
Include water reuse in the scope of future implementation reports of the UWWTD, so that accurate information is made available on the current status and future potential for water reuse.	O2, O4	
Develop guidance on the implementation of the WFD and UWWTD, i.e.: - Clarify the requirements of Art. 12 of the UWWTD (specify what is meant by 'where appropriate') and provide guidance to MS on how to enforce this article, especially how to evaluate the potential for reuse options whenever new WWTPs are built or existing WWTPs are upgraded; - Provide guidance on cases where water reuse should be given priority among alternative water supply options; and - Encourage MS with water-stressed river basins to assess the contribution water reuse can make under different water stress scenarios and, if this contribution is significant, to have agreed targets for reuse of reclaimed urban wastewater as part of their river basin management plans.	O2, O4	
EU to promote forthcoming ISO water reuse standards as a common referential to be used by the MS for the management of health and environmental risks	O2, O3, O6, O7	
Establish legally-binding water reuse standards¹¹⁴ at the EU level (with several possible approaches)	O2, O3, O6, O7	
Require MS with water-stressed river basins to assess the contribution water reuse can make under different water stress scenarios and, if this contribution is significant, to have agreed targets for reuse of reclaimed water as part of their river basin management plans.	O4	

¹¹⁴ The term 'standard' used in this report refers to different types of documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that water reuse projects achieve an acceptable level of health and/or environmental protection. This definition is in line with the ISO definition of a standard.

Possible EU policy measures	Related specific objectives	Comments
Contribution of water reuse to soil fertilisation to be taken into account in the EU legislation on fertilisers	O2, O5	The effectiveness of this policy measure with regard to the water reuse optimisation objective seems limited, compared to other policy measures. Hence it has not been taken forward.
Include water reuse in good environmental condition rules under the cross-compliance mechanism of the CAP	O4	The feasibility of this policy measure is low in the short term, given the recent CAP reform; hence it has not been taken forward.
Address the management of health and environmental risks of water reuse as part of the EU legislation on sewage sludge recycling	O3	Such a measure would contribute to achieving the requirements of the EU food safety legislation, by preventing potential contaminants substances from entering the food chain. It would therefore ensure a higher level of safety, by not only relying on inspections carried out on grown products. While there are some benefits in setting up a consistent framework for the management of risks associated with reclaimed water and sewage sludge in agriculture, a main drawback of this option is to associate water reuse with waste recycling, which could go against the objective of enhancing public acceptance. For this reason, this policy measure has not been taken forward.
Support innovation in reclamation technologies and the up-skilling of EU professionals in the water sector Support research related to emerging pollutants in reuse schemes and their fate (impact on soil, health and environmental effects, etc.)	O8	The EU already provides funding to research activities, studies and training programmes in the field of water reuse, hence this funding needs to be pursued. As several funding and innovation supporting measures are already in place at the EU level (see Section 2.4.2), these measures are not further investigated as part of the present study.

3.3 Policy options to be further assessed

It is proposed to group the policy measures identified in the previous section into several policy options, defined by increasing level of ambition and increasing level of efforts required:

- **Option 0:** No policy change.
- **Option 1:** Information, communication and knowledge enhancement measures including EU guidance development, knowledge sharing and awareness raising actions.
- **Option 2:** Legally-binding EU standards on water reuse, with three sub-options:
 - **2.A.** Legally-binding quality criteria
 - **2.B.** Legally-binding risk assessment and management framework
 - **2.C.** Legally-binding technological criteria.
- **Option 3:** Legally-binding requirement for MS to assess the contribution that water reuse can make to address water stress and, if this contribution is significant, to have agreed targets for the use of reclaimed water as part of their river basin management plans.

The definition and rationale of each policy option are explained below.

Option 0: No policy change

This option corresponds to the business as usual scenario. No further EU policy actions to promote water reuse will be taken under this scenario. This option, however, involves the continuation of existing EU policy measures aiming to support water reuse, in particular support to innovation through EIP Water, funding of research projects on water reuse and funding of water reuse projects through the European Structural and Investment Funds (ESIF) (as described in Section 2.4.2).

This option also takes into account the expected results from the future implementation and enforcement efforts related to the EU water policy, in particular the WFD and the UWWTD.

Option 1: Information, communication and knowledge enhancement measures

This option would be a package of measures aiming to address the information, communication and knowledge-related barriers associated with water reuse, as follows:

- Development of a **harmonised set of definitions and Key Performance Indicators (KPIs)** for the reporting of water reuse data across the MS¹¹⁵, and **improvement of the quantitative knowledge basis**. A harmonised set of definitions is considered to be an essential element to have a common understanding of water reuse within the EU, to accurately quantify the contribution that water reuse can make to addressing water scarcity in the various river basins, and to enable a reliable comparison of the extent of water reuse practices between the MS. The development of this set of definitions and KPIs would need to take into

¹¹⁵ Reporting to Eurostat and reporting under the UWWTD

account the ongoing work of the ISO on this subject. The improved knowledge basis should include, in particular, updated quantitative projections of the water reuse potential in each MS over the next 10 years, and improved national reporting of reused water volumes through Eurostat (the latest data (2009) is only available for four MS) and through future implementation reports of the UWWTD.

- **Awareness raising campaigns, development of awareness raising tools and dissemination of information** on the various benefits of water reuse, among all key stakeholders. These would have two main objectives: to build trust, credibility and confidence in water reuse solutions (addressing health risks-related concerns of the general public and workers potentially exposed to reclaimed water); and raise awareness on the benefits of reuse for the various stakeholders involved in the development of reuse schemes. The implementation of such instruments could build on previously developed guidance (e.g. guidance on participative planning developed by the EU-funded AQUAREC project), on successful examples (e.g. reclaimed water project developed for the 2012 London Olympic Games; NEWater project in Singapore), and could involve working with NGOs to help build trust among the different groups of stakeholders that need to be targeted. Recent research has shown that key success factors to gain public acceptance are to make people aware of the water cycle – and thus the existence of unplanned potable reuse, of the need to recycle water and of the associated benefits (see Section 2.8.3.3).
- **Development of a good practice reference document on water reuse**, resulting from a knowledge exchange between MS and other stakeholders. This work could be included in the mandate of the CIS working groups. The document could then be used as a basis for the development of future legislation on common standards. It would contribute to addressing information failures as well as the lack of clarity on water reuse-related requirements in the EU policy framework.
- **Promotion of forthcoming ISO/CEN water reuse standards by the EU**, as a common referential to be used by the MS for the management of health and environmental risks. ISO standards on water reuse for agricultural irrigation are expected to be published for 2015, while there is not yet any defined timeframe for the publication of ISO standards covering other uses (work has just started). This would contribute to addressing the lack of clarity on water reuse-related requirements in the EU policy framework.
- **Development of non-binding EU guidelines on how to foster water reuse through economic instruments**. These guidelines would support the design and implementation of the right price structure and level for water reuse. They would include recommendations in order to address market failures that currently limit the uptake of water reuse solutions (e.g. identifying and eliminating subsidies in main water markets that are detrimental to water reuse, promoting full cost recovery). They would also reflect the most recent knowledge base on cost/benefit analyses of reuse schemes. The development of such guidelines would be accompanied by measures to produce more comprehensive and up-to-date data on the benefits of reuse, including comprehensive cost/benefit analyses, comparative carbon footprints, etc. These guidelines would contribute to addressing the economic barriers related to water reuse.

- **Development of non-binding EU guidelines on the implementation of the WFD and UWWTD.** These guidelines would:
 - Clarify the requirements of Art. 12 of the UWWTD¹¹⁶ and provide guidance to MS on how to enforce this article, especially when new WWTPs are built or existing WWTPs are upgraded;
 - Provide guidance on cases where water reuse should be given priority among alternative water supply options; and
 - Encourage water stressed MS to assess the contribution water reuse can make under different water stress scenarios and, if this contribution is significant, to have agreed targets for the use of reclaimed water as part of their river basin management plans (e.g. a given percentage of the reclaimed water produced within the river basin) (see the Australian example)¹¹⁷.

Option 2: Legally-binding EU standards on water reuse

Option 2 involves the development of **legally-binding common EU standards¹¹⁸ on water reuse**, covering uses for which no EU standards currently exist (i.e. uses other than drinking water production, groundwater recharge and bathing). A first objective of these common standards would be to provide clarity to project developers on how to manage health and environmental risks related to water reuse projects in the EU. Compliance with recognised EU standards would also increase the credibility of water reuse projects and would provide more certainty for potential investors with regard to business risk management. Common standards would also contribute to creating a level playing field for producers of agricultural products irrigated with reclaimed water.

These standards would have to:

- Cover the reuse of reclaimed water from urban and industrial origin;
- Be applicable to all MS, while not requiring MS to rely on water reuse if they do not wish to;
- Be used as a basis for the drafting of water reuse permits; and
- Reflect current scientific knowledge on health and environmental risks of reclaimed water reuse.

In addition, in order to be effective in avoiding potential trade barriers, this policy option should be designed so that MS would not be tempted/allowed to implement more stringent requirements with regard to irrigation of food crops. When defining the level of ambition of the EU standards, a compromise would therefore have to be found between:

- The need to provide a sufficient level of assurance to stakeholders with regard to safety aspects;

¹¹⁶ In particular, specifying what is meant by '*Treated waste water shall be reused where appropriate*'

¹¹⁷ According to EUREAU (EUREAU, 2004), the "Mediterranean climate" regions of Australia have set a target of 20% recycling of wastewater by 2012 and arid regions' targets are set at 50 to 100% wastewater recycling

¹¹⁸ The term 'standard' used in this report refers to different types of documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that water reuse projects achieve an acceptable level of health and/or environmental protection. This definition is in line with the ISO definition of a standard.

- The need to avoid excessive administrative burden and costs for project developers (as this has been observed in FR and IT, in particular); and
- The need to prevent MS from implementing stricter standards at the national level.

The standards would provide a clear framework for managing risks associated with water reuse. This framework would aim to prevent and control the following main risks (at least):

- Risks to public health, considering the various possible exposure pathways;
- Occupational health risks for workers exposed to reclaimed water;
- Agricultural productivity losses (with regard to nutrients load and salinity, in particular);
- Risks resulting from the accumulation of harmful substances in irrigated soils and crops.

Experts agree on the fact that, although numerical standards on a list of substances/pathogens are important, they cannot provide sufficient reassurance of safety on their own. A broader **risk-based approach** is needed, encompassing risk management plans, treatment standards, treatment process controls, application controls and water quality benchmarks.

Three sub-options are proposed with regard to the content of the standards and their legal status (legally-binding vs indicative requirements):

- **Option 2A. Legally-binding quality criteria** – i.e. defining a range of water quality parameters with minimum thresholds that the water produced from a reuse scheme must meet. These quality parameters would be tailored (with varying degrees of granularity) to specific categories of water use such as irrigation of particular agricultural products or non-potable urban uses. Such quality standards would be associated with prescribed monitoring and reporting measures that scheme operators would need to adopt in order to demonstrate that water quality parameters are being met. It should be noted that, in the six MS that have water reuse standards in place, these standards rely strongly on quality criteria (legally-binding criteria, except in PT); these quality criteria are complemented by a number of other requirements, such as application controls (see Annex B for further details).
- **Option 2B. Legally-binding risk assessment and management framework** – i.e. defining a planning and management process that reuse scheme operators must undertake in order to obtain approval for their schemes (such as the risk assessment framework proposed in the Australian Guidelines for Water Recycling). This process would require scheme operators to wholly assess the risks associated with their scheme and propose targeted control and monitoring measures in order to reduce risks to an acceptable level. The suite of measures would be incorporated into a **risk management plan** which could itself become a binding document¹¹⁹. Plans would include minimum thresholds for water quality parameters, but these would be bespoke to the particular scheme. The risk management plan would need to be approved by the competent authorities in order for the scheme developer and user(s) to be granted a permit.
- **Option 2C. Legally-binding technological criteria** – i.e. defining a set of pre-approved or certified treatment technologies for reuse schemes (such as the Title 22 certification system in California). Reuse schemes would then be considered compliant

¹¹⁹ For further details on the possible contents of risk management plans, see JRC (2014)

if they incorporated certified technologies and maintained them within certain operational parameters. This would also require the development of a process through which technology providers could obtain certification for their products. Additionally, such standards would need to be updated regularly to accommodate technological innovations.

Key items associated with each of these sub-options are summarised in Table 9 below.

Table 9: Policy option 2 – Key items that could be part of the standards

Key specifications included in the standards	Nature of the requirements		
	Option 2A	Option 2B	Option 2C
Risk assessment framework and key contents of risk management plans	–	<i>Legally-binding</i>	–
List of acceptable uses and possible use restrictions	<i>Legally-binding</i>	<i>Legally-binding</i>	<i>Legally-binding</i>
Reclaimed water quality criteria for different uses (numerical limit values for a range of parameters)	<i>Legally-binding</i>	Indicative	Indicative
Wastewater treatment requirements for different uses	Indicative	Indicative	<i>Legally-binding</i>
Key aspects of the permitting procedure for water reuse schemes (overall process, information needed for the application, contents of the permit, etc.), for applications not covered by specific existing EU permitting requirements	<i>Legally-binding</i>	<i>Legally-binding</i>	<i>Legally-binding</i>
List of application controls (irrigation methods, crop selection, setback distances, exclusion zones, signalling, design of distribution and storage infrastructure, etc.) – To be adapted on the basis of the risk assessment, subject to approval by public authorities	Indicative	Indicative	Indicative
Monitoring requirements (types of parameters, methods, frequency of sampling and analysis, roles and responsibilities, etc.)	<i>Legally-binding</i>	<i>Legally-binding</i>	<i>Legally-binding</i>
Communication of monitoring results to relevant third parties	<i>Legally-binding</i>	<i>Legally-binding</i>	<i>Legally-binding</i>
Definition of roles and responsibilities	<i>Legally-binding</i>	<i>Legally-binding</i>	<i>Legally-binding</i>

A preliminary analysis of suitable policy instruments for implementing Option 2 can be found in Annex F.

Option 3: Requirement to assess the potential for setting water reuse targets in water-stressed river basins

Under Option 3, MS with water-stressed river basins would be required to assess the contribution water reuse can make under different water stress scenarios and, if this contribution is significant, have **agreed targets** for use of reclaimed water as part of their river basin management plans. For example, the targets could be expressed as a given percentage of the reclaimed water produced within the river basins (see the Catalan¹²⁰, Portuguese¹²¹ and Australian¹²² examples) or a given percentage of the total water withdrawals within the river basins.

It is assumed that some flexibility would be left to MS in order to take into account the local geographical and socio-economic context in their decision to set up water reuse targets at the river basin scale (e.g. distance between offer and demand).

This option would aim to give water reuse more visibility in existing EU legislation, so that water reuse becomes a key component of integrated water management.

¹²⁰ The Catalanian Water Agency set a target of 31% of water reuse by 2015, after having assessed the reuse opportunities around the main urban WWTPs (see Annex E for more details)

¹²¹ In Portugal, 10 % of wastewater was to be reused by 2013 (but this target was not achieved)

¹²² The Australian Government itself committed to a national target of recycling 30% of wastewater by 2015. In addition, many major cities and several states have set targets to achieve specific percentages of wastewater recycling (see Annex E for more details)

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ANNEX A: Overview of water reuse practices in the EU Member States

This annex provides a compilation of information on water reuse practices in the Member States, coming from the following main sources:

- A study by Angelakis et al. prepared for EUREAU in 2007 (Angelakis et al., 2007);
- A report by TYP SA prepared for DG ENV in 2013 (TYP SA, 2013); and
- Questionnaire replies as well as supporting documents and written comments/updates sent by several Member States as part of the present study.

Austria

Context

Angelakis et al., 2007 (updated by the Federal Ministry of Agriculture):

Austria has a mean yearly rainfall of ca. 1,100 mm. The total amount of water demand accounts only 3% of the yearly available water resource of about 77 Mm³¹²³. Due to this favourable situation, water availability is only a limited local problem during occasional droughts mainly in some eastern and southern parts of Austria. Average drinking water consumption is about 135 L/inh./day¹²⁴. Almost 100 % of the drinking water derives from ground water (including 50% spring water) and needs no or nearly no treatment.

Water reuse practices

TYP SA, 2013 (updated by the Federal Ministry of Agriculture):

Due to the abundant water resources, water reuse is not a major issue in Austria.

Due to the Water Act, Austria has a very strong precautionary principle for ground and surface water protection. In case of permits for industrial uses, the specific water abstraction is limited to a value, which corresponds to BAT for these water uses (including recycling of water e.g. in pulp and paper industry, sugar industry). Therefore, the basic goal of water protection in Austria is to make rational use of water and to minimise material flows to the receiving waters. Source control of water pollution has a high priority.

¹²³ Source: Austrian Organisation for Gas and Water, 2013

¹²⁴ Source: Austrian Organisation for Gas and Water, 2013

Belgium

Context

TYPSA, 2013 (updated by the Flemish Environment Agency):

Ten years ago, only 38% of all sewage was treated in Belgium. We know this number has currently increased and is still going up: the current sewage treatment degree in the Flemish Region amounts to 81.2% and in the Walloon Region to 84.7 % (status on 01/01/2015). This fast wastewater treatment facilities growth has improved the prospects for possible reuse. However, this will largely depend on the relative costs of traditional sources of water and reused treated wastewater. Belgium is one of the member states presenting a high Water Stress Index. The reduction of effluent discharge in sensitive waters is an additional reason for reuse in Belgium. The Flemish Government wishes to reduce groundwater abstraction and focuses its efforts on stimulating the reduction of water consumption at any time.

Angelakis et al., 2007 (updated by the DGARNE):

As a result of its dense population, several indicators show that Belgium can be considered as one of the most water-stressed EUREAU Countries. Amongst others, the amount of renewable water is relatively low (1,791 m³/capita/year)¹²⁵. This is indirectly translated in a poor groundwater and surface water quality.

Water reuse practices

TYPSA, 2013:

There is a growing interest in reuse namely for industrial water supply (cooling water in power plants, food processing plants, textile industry), agriculture and groundwater recharge although the percentage of treated effluent that is currently reused remains very limited. Several episodes of unplanned indirect reuse have been detected as well.

Angelakis et al., 2007 (updated by the Flemish Environment Agency):

Despite the fact that the amount of wastewater reuse so far remains limited (less than 2% of the total reclaimed water), the reuse of reclaimed water is becoming an essential and reliable option especially in industry, such as power plants, food processing, and other industries with high rates of water utilization and in areas of dropping water tables of high summer water demand such as the coastal regions during the tourist season. Industrial wastewater reuse is being fostered by the Flemish Government. In general, the Government wants to restrict groundwater abstraction to those applications requiring higher groundwater quality, e.g. by increasing the groundwater extraction fees.

Examples of reuse schemes

Angelakis et al., 2007:

Eight municipal wastewater reuse projects are now operational. Many other projects are in a more or less advanced planning phase. In Wulpen WWTP, 2.5 million m³/yr of urban wastewater is treated by microfiltration (MF) and reverse osmosis (RO), stored for 1-2 months in

¹²⁵ OECD website on water resources (reporting from the 'Joint OECD/Eurostat questionnaire on inland waters'): http://stats.oecd.org/Index.aspx?DataSetCode=WATER_RESOURCES

the aquifer, and used for water supply augmentation. Specific infiltration consents have been introduced for this project.

A similar project has been under investigation in Heist, where different options to increase the potable water supply have been considered, such as MF/RO filtration of surface water. The reuse of 10,000 m³/d WWTP wastewater after MBR and RO treatment has been rejected because of the fact that a natural treatment step through e.g. infiltration was technically impossible. A “natural” treatment step was considered imperative for safety reasons and social acceptance, although the quality obtained through MBR/RO was sufficient to be considered for direct potable reuse.

In another case, in Waregem, a 3.0 M m³/yr direct WWTP reuse project for textile industry has been investigated. The technological feasibility has been demonstrated, but the ideal financing construction is still under discussion.

There is a documented case of established wastewater reuse in Belgium for agricultural purpose for the irrigation of crops, mainly in summertime. Additionally, the University of Gembloux had developed a system, called “Epuvalisation”, to reuse the wastewater wastewaters in hydroculture (Xanthoulis and Guillaume, 1995)¹²⁶.

Bulgaria

Water reuse practices

TYPSA, 2013:

Even though being Bulgaria the second country with more water stress in the European Union, no specific data related to reuse of reclaimed water have been found. Possible final wastewater reuse systems have been usually considered in particular cases concerning the quantity, contents and the treatment technology of industrial wastewater. Such cases would involve the industries of Thermal Power Plants (cooling water), refrigeration installations (cooling water), food industry, paper industry and processing of non-metal mineral resources (kaolin, for example).

Croatia

Context

Angelakis et al., 2007:

Croatia consists generally of two climatic regions. The northern part belongs to the central European region, with typical continental climate and abundant in water resources. In this region there are no major problems related to water supply. The coastal western part belongs to the Mediterranean Region, with climate conditions characterized by long, dry summers and more humid autumn-winter periods. These conditions, together with specific karstic hydro-geological features contribute to the relatively low water resources availability. In certain parts of that region (most of the islands) the available water resources have already being exploited to their full capacity, creating water supply problems for domestic, industrial and especially agricultural

¹²⁶ Xanthoulis, D., and Ph. Guillaume (1995). Irrigation of vegetable crops as a means of recycling waste. In: Proc. of 2nd Int. Symposium on Wastewater Reclamation and Reuse (A. N. Angelakis et al., Eds.), IAWQ, 17-20 Oct., Iraklio, Greece, 2: 713-724

use. Water supply problems in this region manifest in the fact that the largest water consumption for both the tourist resorts and the agricultural needs coincide with the dry season.

Water supply problems in Croatia manifest in the fact that the largest water consumption for both the tourist resorts and the agricultural needs coincide with the dry season as it happens in most of the Mediterranean areas. Reuse of reclaimed water in Croatia in any form of water supply has not been practiced so far. Water supply for population and tourists in the coastal areas has been practiced by transporting the water from the coast to the islands by submerged pipes and from locations rich in water (coastal rivers and springs) to other coastal areas. Nevertheless, future development of these systems becomes expensive, both because of investment and operation costs. Such practices do not include water supply for agricultural purposes. Then, in this area there are needs for new water supply sources like desalinisation, which have already been practiced for water supply for population and tourism on the small islands near the coast, (Margeta, 2002). Most of the towns in the coastal areas although small, are characterized with high fluctuation of population (tourists) and consequently uneven production of wastewater. The pretreated wastewater is discharged into the sea through long submerged outfalls. Prior to the wastewater discharge there is only preliminary treatment.

Water reuse practices

Angelakis et al., 2007:

In coastal, tourist area, there has been some private initiatives regarding reuse of wastewater for irrigation. The main possible future use of reclaimed water could be irrigation of tree crops, vineyards, olive trees, etc. as well as landscape irrigation.

Cyprus

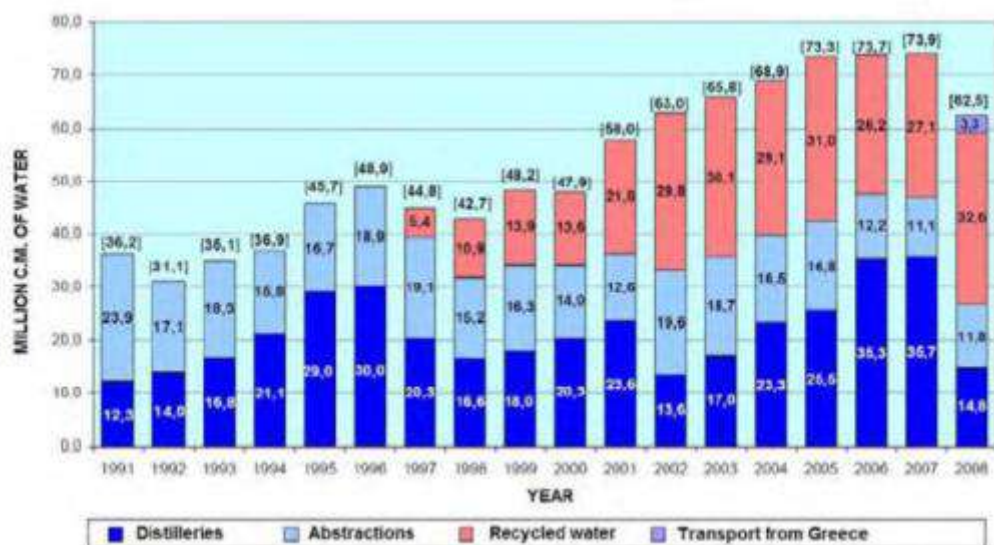
Context

TYP SA, 2013:

Cyprus is an island where tourism is a very important economic activity. Water scarcity and deterioration of bathing water on the beaches are growing as constriction factors to tourism development. The reuse of reclaimed water is an important contribution to the solution of both problems. Irrigation for several purposes (agriculture, landscape, green areas in hotel, golf courses) is the main application in Cyprus.

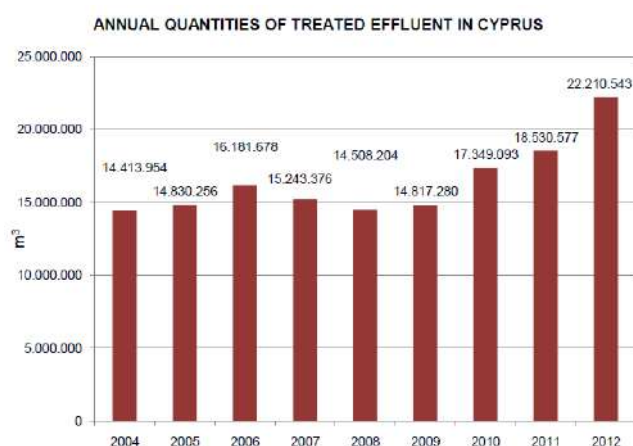
In Cyprus the annual precipitation is about 500 mm, 85% of which is estimated to be lost by evapotranspiration. Current total water use is 242 Mm³/yr., almost 80% used for irrigation.

The evolution of Cyprus water sources exploitation is shown below. Reclaimed water is an indispensable source for this country and it is to be expected that will still be in a future.



Information from the Water Development Department:

The following figure presents the annual wastewater production quantities in Cyprus for the years 2004 to 2012.



A volume of 65 million m³ and one of 86 million m³ are expected in 2015 and 2025 respectively.

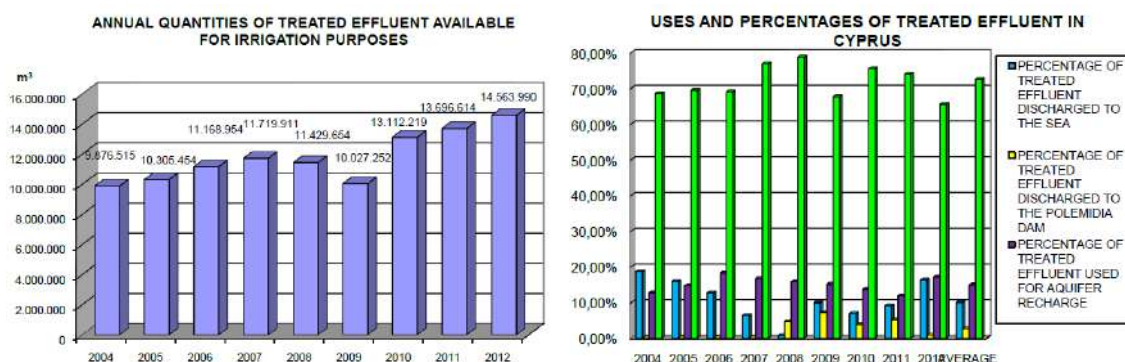
34 urban WWTPs are currently operating in Cyprus (see the table below).

	Categories of WWTPs	Number of WWTPs	Total Capacity (m ³ /day)
1	Existing Urban WWTPs (>2000 p.e.)	8	165 700
2	Existing Rural WWTPs (> 2000 p.e.)	7	2 601
3	Existing Rural WWTPs (< 2000 p.e.)	4	506
4	Existing WWTPs for Refugee Housing	3	760
5	Existing WWTPs for Hospitals	3	1 280
6	Existing WWTPs for Military Camps	9	684
	TOTAL	34	

Water reuse practices

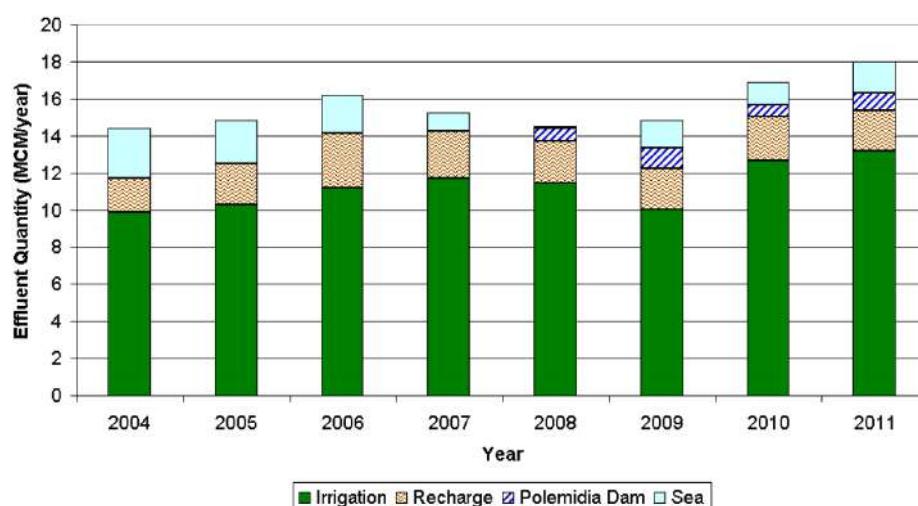
Information from the Water Development Department:

The following figure presents the percentages of treated effluent reused as well as the annual quantities of treated effluent available for irrigation purposes for the years 2004 to 2012.



A large proportion of reclaimed wastewater is used for irrigation – whether for agriculture, public parks or golf courses – accounting for more than 60% of total water demand (Anastasiou et al., 2012) (Figure 10).

Figure 10: Quantity of treated effluent used in Cyprus (Mm³/yr), between 2004-11, categorised by use (Anastasiou et al., 2012)^{127,128}



The main driver for water reuse in Cyprus seems to be tourism, an important economic activity on the island but one that has recently experienced a major slowdown: in 2006, revenue from tourism as a percentage of GDP was 12.3%; down from 20.6% in 2000 (Sofronis et al., 2007). Using reclaimed water for irrigation of recreational and urban areas saves money and contributes to improving Cyprus' competitiveness as a tourist destination.

Examples of reuse schemes

¹²⁷ Polemidia dam is one of the dams used to store water in Cyprus. Dams are an important source of water both for domestic and agricultural use.

¹²⁸ Irrigation refers to several uses including agriculture, golf courses, etc.

Reuse of wastewater produced by the Limassol WWTP (Anayiotou, 2005)

In 2005, more than half of the wastewater treated in Limassol WWTP was used for direct irrigation. A very small percentage was directed to the Polemidia dam. Overall, the recycled wastewater was used for irrigation of agricultural areas, green areas in hotels and for industrial use (cement factory).

Irrigation with wastewater produced by the Larnaca WWTP (Anayiotou, 2005)

The treated effluent has been used for irrigation purposes since 2000. An average agricultural area of about 250 hectares is being regularly irrigated. A variety of animal plants (corn, alfalfa, etc.) are regularly irrigated with the reclaimed water. The treated water is also used by hotels connected to Larnaca WWTP, and by Larnaca Municipality for the irrigation of gardens, parks and football fields during the summer season.

Artificial recharge of the Ezousas aquifer with tertiary treated sewage from the Paphos WWTP (Anayiotou, 2005; Water Development Department of Cyprus, 2013)

Since 2004, disinfected tertiary treated water recharges the aquifer through specially constructed shallow ponds. This water, after natural purification, is pumped again from the aquifer for irrigation in the Paphos Project area. Pumping is carried out strategically so that retention time in the aquifer is maximised.

Czech Republic

Context

TYPSA, 2013 (updated by the Ministry of the Environment):

The Czech Republic is located at the watershed of three seas and most of the Czech watercourses flow into neighbouring countries. Priority issues for freshwater are water quality and pollution. Even though surface water quality has improved significantly since the 1990s, there is still a need to focus on the discharge of pollution and improve wastewater treatment.

Water quality is also affected by the increasing number and extremity of floods and droughts associated with climate change. Action is required here to help retain water in the landscape and support flood-protection measures. Given that droughts are increasingly frequent, the continuing decrease in water abstraction in the public sector and in industry is applauded.

The Czech Republic has a strong precautionary principle for surface and groundwater protection that is why the main aim of our water protection is to make rational use of water and to minimize flow of materials into the receiving waters.

Volume of treated urban wastewater produced in the Czech Republic is 850 Mm³ per year and it is expected to decrease slightly in the future due to above mentioned rationale use of water.

Water reuse practices

Information from the Ministry of the Environment:

There is a negligible reuse of treated municipal wastewater as there is no existing policy framework for it. Only industrial wastewater is being reused in case where it results in overall economic and ecological advantages.

Reuse of municipal wastewater is nowadays negligible but it is expected to increase in the future, the main use of treated municipal wastewater will be for the irrigation.

Denmark

Context

Angelakis et al., 2007:

Denmark's 5 million inhabitants can count on a freshwater availability of approximately 2,500 m³/capita/year (Eurostat). The water supply almost entirely relies on groundwater resources. Thus managing groundwater quality and quantity is of paramount importance for a sustainable water supply and use. Denmark WSI has been rated between 15 and 20%. High water prices encourage industries to recycle process and cooling water.

Water reuse practices

Information from the Environment Ministry (presentation made the at the CIS working group meeting of Nov 2013):

There are currently few cases of water reuse in Denmark, however significant interest in water reuse has emerged recently, as a way to preserve high quality drinking water supply resources. 100 % of the drinking water in Denmark now derives from ground water; this water has a high quality and is therefore not chlorinated.

The Danish Ministry of the Environment has a focus on water efficiency as a result of pressure on water resources - especially in Eastern Denmark. Manufacturing companies have increased focus on optimization as a result of high water and electricity prices. Denmark is increasingly focussing on the possibilities for using water of another quality than drinking water.

Examples of reuse schemes

Angelakis et al., 2007:

One of the best known examples is the industrial symbiosis of Kalundborg where several companies inter alia mutually provide and recycle wastewater.

Estonia

Context

Angelakis et al., 2007:

In Estonia a lot of attention is paid to sewage treatment. In several towns new wastewater treatment plants supplied with modern technology have been implemented in the last years. In 2003 the amount of sewage to be treated was 119 Mm³/yr from which the rate of untreated sewage was less than 1%. The main treatment method is biological-mechanical treatment that forms ca 50% from the total amount of sewage to be treated. Biological treatment forms 46% and mechanical treatment 4%.

Wastewater involves also mine water that consists mainly of drainage water from the oil shale mines. In 2003 the amount of mine water was 212Mm³/yr. This kind of wastewater which is not typically clean wastewater is treated mainly mechanically in the sedimentation pools. Part of the mine water does not need any treatment. Thus the discharged sewage can be divided in Estonia as follows: (a) drainage water from the mines 212 mill m³/yr from which 87% is treated

in the sedimentation pools and (b) household and industrial sewage that needs treatment 119 Mm³/yr (Jankovski, 2004)¹²⁹.

Water reuse practices

Angelakis et al., 2007:

Recycling of wastewater is not applied in Estonia except to a limited amount in some industrial enterprises. In this case, it can be called recycling of conditionally clean wastewater (Jankovski, 2004)¹³⁰.

Information from the Environment Ministry of Estonia, 2014¹³¹:

Estonia has just started investigating the potential for reusing treated urban wastewater, although the country is not subject to water stress. At present, treated urban wastewater is not reused because this is not allowed by the national legislation.

Finland

Context

Angelakis et al., 2007 (updated by the Environment Ministry):

With water availability per capita of more than 20,000 m³/yr. and with Water Exploitation Index around 2%, Finland never needed to consider the reuse of reclaimed water for irrigation or for any other uses, for that matter. The water abstraction for public water supply is 400 Mm³/yr and over half of that is groundwater. The industrial use of water is 1,000 Mm³/yr. and the use of cooling water is 5,700 Mm³/yr. The need of irrigation in agriculture is quite low. The use of water for irrigation is less than 1% of the water availability and 90% of it is high quality surface water.

The main reason for the low uptake of reuse solutions is that sufficient quantities of water have been available from other sources. Recently, water reuse – predominantly grey water reuse – has been considered in connection with the resource efficiency and green economy of the society and industries. The resource efficiency has improved significantly by recycling industrial process water (internal recycling) so that the water use per tonne of product has decreased notably. Also the per capita water use of waterworks for municipal water supply has decreased as a result of improved efficiency.

France

Context

TYPESA, 2013:

The consumption of water for farming is growing strongly in South-Western France and the Paris region in particular, whereas consumption for industry seems to be falling, and domestic consumption has reached a ceiling that now even seems to be slowly declining.

In addition to the growing demand for water for agricultural purposes, some irrigated crops (such as corn) have become more widespread and periodical droughts have occurred. Over the

¹²⁹ Jankovski, H. (2004). Personal communication, e-mail: harri.jankovski@evel.ee

¹³⁰ Jankovski, H. (2004). Personal communication, e-mail: harri.jankovski@evel.ee

¹³¹ Verbal information (stakeholder consultation workshop, Dec. 2014)

last 20 years and more particularly there has been a long period of drought which has paradoxically affected the regions traditionally considered to be the wettest, in Western and North-Western France. In more than one-third of the country, water tables are falling as the autumn and winter rains are no longer making up for the amounts drawn up in spring and summer. Faced with this situation, the authorities have occasionally imposed restrictions on water use, a very unusual practice in France. It is also worth recalling that around fifteen French departments are situated in an area with a Mediterranean climate similar to that of Northern Spain and Italy, well-suited to market gardening, fruit farming and mass tourism. All of these tend to increase the need for water, at the time when resources are periodically insufficient. However, these departments do not experience serious water shortages because they were equipped with canals bringing water from the Durance and Rhone rivers.

Water reuse practices

Information provided by SYNTEAU (2014):

There are no recent data on the total volume of reused water in France (latest data are from 2007: 19,200 m³/day according to Jimenez et al.). At present, there are about 40 reuse schemes in France, most of them are dedicated to irrigation (agriculture, public areas, golf courses and racecourses).

TYPSA, 2013:

Because of its good hydraulic infrastructure and sufficient rainfall around the country, France does not need to increase resources by relying heavily on wastewater reuse. So far, apart from the large Paris project, most applications of wastewater reuse have been limited to peripheral small communities and islands mainly because of the cost of tertiary treatment. Nevertheless, the projects implemented cover more than 3,000 ha of land, and quite a wide variety of applications: market gardening crops, orchard fruit, cereals, tree plantations and forests, grasslands, gardens and golf courses.

Angelakis et al., 2007:

The reuse of industrial wastewater after purification to supply cooling water, wash water or even process water after sophisticated complementary treatment is widely developed in France. There are more than 10 MBR projects in industrial wastewater treatment in France with examples in the automotive, textile, paper, food industries of industrial wastewater. In some of these applications for the paper and food industry the treated water is reused. The applications also include rainwater catchment and reuse at a large automotive plant.

Examples of reuse schemes

Angelakis et al., 2007:

Even though France has an ample availability of freshwater with an average rainfall of 600mm/yr thirty municipal wastewater reuse projects have been implemented. These include 15 projects for agricultural irrigation, 9 projects for irrigation of golf and 6 projects for irrigation of urban areas. (Durham et al., 2005).

Only 30 projects have in fact been carried out up to now, mainly because of the relative abundance of water resource. The projects implemented cover more than 3000 ha of land, and

quite a wide variety of applications: market gardening crops, orchard fruits, cereals, tree plantations and forests, grasslands, gardens and golf courses (Faby et al, 1999)¹³².

Information from the Environment Ministry:

Few additional projects have been developed since 2006. Reportedly, this is partly due the changing regulatory environment (water reuse standards) which has generated a lot of uncertainty among potential investors.

A full list of water reuse projects has been compiled in 2008.

The Clermont-Ferrand reuse project (Veolia factsheets; Angelakis et al., 2007)

The Clermont-Ferrand recycling scheme for irrigation of over 700 ha of maize with a 40 km distribution system is today considered to be one of the largest projects in Europe. Since 1997, 700 ha have been irrigated with reclaimed water. Irrigation is supplied with effluents of a sugar mill factory, stored in 8 lagoons (12 ha and 312,000 m³) from October to May, then with the urban effluent during the rest of the irrigation season. The lagoons act as tertiary treatment with a residence time of more than 10 days to reach a B to A standard of the French regulation.

Water reuse in the Pornic seaside resort (Veolia factsheets)

The City of Pornic improved its wastewater system in order to produce water suitable for irrigation. Reclaimed water is currently used to irrigate the Pornic golf course, but the city intends to extend its use to irrigate public green spaces.

By reusing water this way, the city has reduced the amount of water withdrawn from its water resources and has improved beach water quality because less water is discharged into the ocean. This is important because the environmental quality is an important selling point for tourism in the city.

Water reuse in Sainte-Maxime, Côte d'Azur (Veolia factsheets)

The City of Sainte-Maxime is located in a highly touristic area, so this case is similar to Pornic. In Sainte-Maxime, reclaimed water is also used to irrigate a golf course, which provides the town with an environmentally friendly image.

Germany

Context

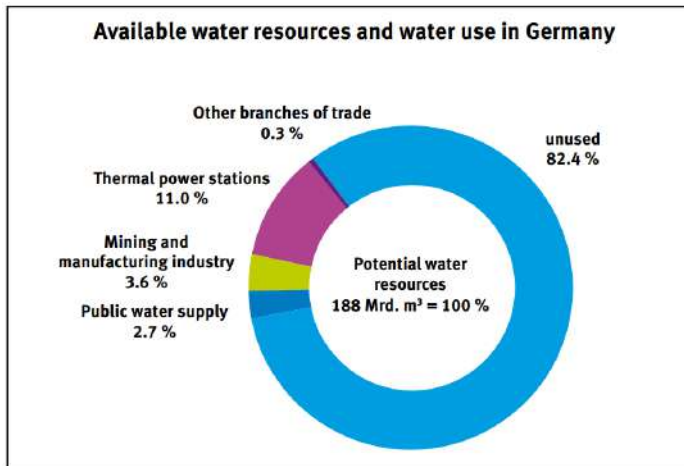
Angelakis et al., 2007 (updated by the Federal Ministry for the Environment):

In Germany, the available amount of water reaches 188 billion m³/yr. Since 2004 all relevant water using sectors (power stations, industry, public water supply, agriculture) together have used less than 20% of the available water amount. In 2010 only 17.4 % of the available water amount was used: 11% by power stations 3.6% by industry, 2.7% by public water supply and less than 1% by agriculture¹³³. Recalling that the main part of water is used for cooling purposes and directly discharged after usage, there is little incentive for the recycling of wastewater.

Available water resources and water use in Germany, in 2010, are illustrated in the figure below:

¹³² Faby, J.A., F. Brissaud and J. Bontoux. Wastewater reuse in France: water quality standards and wastewater treatment technologies. Wat. Sci. Tech., 1999, 40(4/5):37-42. Government of Western Australia (2003). Securing our water future – A state water strategy for Western Australia

¹³³ <http://www.umweltbundesamt.de/daten/wasser-als-ressource>



Source: Federal Environment Agency (UBA) according to data supplied by the Federal Statistical Office (2013) and the Federal Institute of Hydrology (BfG) (2013).

Water reuse practices

Angelakis et al., 2007 (updated by the Federal Ministry for the Environment):

Water reuse is practiced in the industrial sector. Currently the rate of water reuse in the industrial sector is 4.3%. This low rate is due to fact that also power stations with their high demand for cooling water are statistically counted as industrial plants.

Nowadays, agricultural irrigation does not account for a large proportion of overall water reuse in Germany (0.9%), especially when compared to southern-European countries, but it can have local impacts on resource availability due to the high peak in demand during summer periods. In Germany, fields have been irrigated with wastewater since the end of the 19th century (Seeger, 1999). At first, this method was used as a means to naturally treat wastewater but, due to the high pollution level, in most cases this practice was ceased in the 1980's. In the agricultural sector, water reuse is practiced only in two small-scale areas with sandy soils. In these two areas, untreated wastewater was formerly used as irrigation water, but with the implementation of sewage treatment the irrigation method remained. Nowadays the wastewater treatment plants supply irrigation water either directly to the users, or via infiltration and groundwater recharge.

In the agricultural sector, water reuse is practiced only in two small scale areas. This is due to historical development where in regions with sandy soils agriculture has always only been feasible when irrigated. Formerly this was accomplished by untreated wastewater, but with the implementation of sewage treatment the method remained. Nowadays the wastewater plants provide the irrigation-water in two ways: they distribute the treated water directly or via infiltration and groundwater recharge¹³⁴.

The wastewater treatment is operated in line with the requirements of the intended use: low nutrient degradations are achieved in summer during the vegetation period whereas during winter the sewage is denitrified, phosphorus is removed and the treated water used for groundwater replenishment.

¹³⁴ <http://www.abwasserverband-bs.de/en/what-we-do/the-braunschweig-model/>

In some regions (e.g. Ruhr valley and Rhine valley) the artificial recharge of groundwater for irrigation purposes is practiced as well. However, in these cases, surface water or riverbank filtrate is used as raw water for drinking water production.

According to information provided by the Environment Ministry, the main reason for the low uptake of reuse solutions (outside the industry) is that sufficient water is available from other sources.

Examples of reuse schemes

Reuse for aquifer recharge in Berlin (Veolia factsheets)

For 120 years, the City of Berlin has relied on the recycling of appropriately treated wastewater which is mixed with the surface water. This water is subject to bank filtration as it recharges the aquifers used as a potable water source. Berlin set up an integrated water cycle management involving reusing reclaimed water to recharge aquifers. In general the bank filtration lakes contain between 14 and 28% of Berlin's advanced reclaimed water. The filtrate partially recharges the groundwater which provides drinking water to Berlin. Advanced treatment prevents environmental pollution of sensitive surface and groundwater.

Reuse of wastewater for irrigation purposes in Braunschweig (Fuhrmann, 2012)

Irrigation reuse and infiltration-percolation of reclaimed water for later reuse has been operated for decades. In total, more than 3,000 ha are irrigated (sprinkling) with reclaimed water from the Braunschweig WWTP. On average, 16 million m³/year are used for direct irrigation and 6 million m³/year are infiltrated and reused later on using a percolation-drainage system.

Greece

Context

Angelakis et al., 2007 (updated based on information provided by the author):

In Greece, water demand has increased tremendously over the past 50 years. Despite adequate precipitation, water imbalance is often experienced, due to temporal and regional variations of the precipitation, the increased water demand during the summer months and the difficulty of transporting water due to the mountainous terrain. In addition, in many south-eastern and island areas there is severe pressure for water demand, which is exacerbated by especially high demand of water for tourism and irrigation (Angelakis et al., 2003)¹³⁵.

In 2009, it was estimated that more than 75% of the Greek population was connected to WWTPs with a total capacity of over 1.50 Mm³/day. An analysis of data concerning the water balance of the areas of the treatment plants demonstrated that more than 83% of the treated effluents are produced in regions with a deficient water balance (Tchobanoglous and Angelakis, 1996)¹³⁶. Therefore, reclaimed water reuse in these areas would satisfy an existing water demand.

TYPSA, 2013:

¹³⁵ Angelakis, A.N., L. Bontoux, and V. Lazarova (2003). Main Challenges and Perspectives for Water Recycling and Reuse in EU Countries. *Wat. Sci. Tech.*, *Wat. Supply*, 3(4): 59-68

¹³⁶ Tchobanoglous, G. and A.N. Angelakis (1996). Technologies for wastewater treatment appropriate for reuse: Potential for applications in Greece. *Wat. Sci. Tech.*, 33(10-11): 17-27

More than 88% of the effluents from wastewater treatment plants are discharged at less than 5 km from the available farmland, therefore the additional cost for irrigation with reclaimed wastewater would be low.

Water reuse practices

Ilias et al., 2014:

Only a few projects of effluent reuse have been implemented, most of them being pilot projects of crop or landscape irrigation. The most important projects which are currently in practice are those of Thessaloniki, Chalkida, Malia, Livadia, Amfisa, Kalikratia, and Chersonissos. A few other projects are under planning, such as that at Iraklion, Agios Nikolaos and several island regions (for further details, see Ilias et al., 2014). Finally, it should be mentioned that there are several cases of indirect reuse, especially in central Greece. However, the reuse potential in Greece is limited, since effluent from Athens's WWTP, serving approximately 35% the country's population, is most likely not economically feasible due to the location of the plant (the small island of Psitalia). The possible transportation of 20,000 m³/day of treated effluent from the island back to the city areas for landscape irrigation and industrial use, at an estimated cost of 0.40 EUR/m³, was shown to be not cost effective, at least for the time being.

Tsagarakis et al. (2001) estimated that by reusing effluent of existing WWTPs, in order to increase water availability for crop irrigation and ensure environmental protection, 3.2% of the total water currently used for irrigation would be saved. This percentage has actually been exceeded to reach 4.5% (Paranychiakis et al., 2009). However, the lack of a recycling context and the complex approval processes have inhibited the development of well-organized water recycling projects. Over the last few years, however, the concern for effluent reuse has arisen and many recycling projects are being implemented or planned in Greece, mainly for crop or landscape irrigation.

Information from the Environment Ministry:

Reuse of treated wastewater in Greece is not yet common practice in 2014. Only small scale evaluation projects and feasibility studies have been developed. The reasons are the following:

1. Wastewater and sewage sludge from WWTPs are easily disposed of, especially in coastal areas, without posing any concerns for the treatment plants and their operators.
2. With the exception of islands – most of which suffer from water scarcity – most of Greek regions have sufficient water resources available, with a higher quality and safety level than treated water.
3. There is a general public opposition against the use of reclaimed water for agricultural irrigation.

Examples of reuse schemes

Presentation made by EL at the CIS working group meeting of Nov 2013:

The only large scale application is in Northern Greece, where the Water Supply and Sewerage Company of Thessaloniki (EYATH S.A.), the second largest water company in Greece, serving over a million people, has succeeded in promoting water reuse. For the last 6 years, and only during the summer, the treated effluents from the city's Wastewater Treatment Plant (EELTH) are mixed with river water and used for irrigation of the nearby agricultural areas (. The total flow that goes for irrigation can reach 165,000 m³/day.

A special feature of the project is that the irrigation is free of charge for the farmers.

Part of the wastewater is further treated by filtration and reverse osmosis and used for groundwater recharge; this water is transported to the recharge site by a 3 km pipeline. In certain meteorological and sea conditions, there is intrusion of sea water into the sewage network. It is a common problem in Mediterranean coastal areas, which makes the treated water improper for use due to the high salt content. A Real Time Operational Control Tool of Combined Sewage Overflows (Real-t-SO) has been developed in order to address this problem. It includes water level sensors, meteorological stations, automated gates, etc. (co-financed by the EU).

Hungary

Context

Angelakis et al., 2007:

According to the National Wastewater programme, between 2000 and 2015 the % of houses connected to the sewerage network is to increase from 45% to 75%, the number of WWTPs from 400 to 1,400 and their treatment capacity from 1.7 Mm³/d to 3.1 Mm³/d.

One part of the total amount wastewater produced in 2005 (approx. 500 M m³/yr) is created by households and institutions, while the other part of it is industry originated and the rainwater collected in unified sewage systems. More than ¼ of the 3000 settlements (over 800) is connected to a sewerage network, over half of the population has a sewerage service. 15% of the wastewater gets into the soil without treatment, 85% is drained to the sewerage system. 65% of the latter goes to treatment facilities, 20% today still goes to recipients. The rate of biological treatment method in treatment plants reached 95% in 2005., this rate projected to the whole of the population is 65%, with at least biological level treatment. It will be a significant improvement when in a few years 2 new WWTP in Budapest, and biological treatment plants in Győr and Szeged will be built with EU support.

TYPASA, 2013:

96% of Hungary's surface water comes from the neighbouring countries. Due to this fact, the quality and quantity of the Hungarian water bodies depend greatly on the interventions of these countries. However, Hungarian industrial and agricultural pollution contributes to the contamination of those as well and un- or not well-treated sewage plays a great role in the pollution load of the water supply. Since more than 90% of drinking water comes from groundwater, its protection is a strategic task in Hungary.

About the settlement structure of Hungary it can be stated that the proportion of settlements with less than 2000 inhabitants is high (75.3%) but only 16.9% of the population lives in there. Therefore the proportion of the amount of Hungary's whole wastewater flow coming from these settlements is only 4.7%. Despite of this fact, these are the places where the installation of small WWTUs should be taken into consideration regarding that their uniting into a wastewater treatment agglomeration is not feasible in many cases (mostly when these small settlements are far from each other in addition).

Ireland

Context

Angelakis et al., 2007:

About 75% of Irish drinking water is abstracted from surface water, the remainder being supplied by wells and boreholes. Some 1000 public water supply schemes deliver in excess of 1.2 million m³ of water per day. Because of the mild and wet Irish climate, the need of irrigation in agriculture is practically non-existent. Cooling water tends to be pumped directly from rivers or lakes.

Irish Water Association website (<http://www.iwta.ie/>):

Reuse of treated wastewater does not seem to be practised in Ireland. Interest seems to focus on rainwater harvesting and greywater reuse.

Italy

Context

Angelakis et al., 2007:

A survey of Italian treatment plants estimated the total treated effluent flow at 2,400 Mm³/yr of usable water. In view of the regulatory obligation to achieve a high level of treatment, the medium to large-sized plants (>100,000 inhabitants served), accounting for approximately 60% of urban wastewater flow can provide re-usable effluents for a favourable cost/benefit ratio.

Water reuse practices

Angelakis et al., 2007:

Treated wastewater is used mainly for agricultural irrigation covering over 4,000 ha. However, the controlled reuse of municipal wastewater in agriculture is not yet developed in most Italian regions and has decreased due to the low quality of water.

The total cost (construction, operation and maintenance) for reclamation, in addition to the costs for the distribution of reclaimed water and the monitoring of the whole reuse system, will be difficult to attain and will be probably tolerable only for large WWTPs, thus reducing the benefit of reclaiming water and hampering the development of wastewater reuse practices for the smaller ones; moreover, several successful reuse activities operating since a few years in small communities of Southern Italy inland areas, will certainly be obliged to face problems difficult to cope with.

Examples of reuse schemes

Metropolitan area of Turin (Angelakis et al., 2007)

Municipal WWTP operating companies have planned to build a separate supply network for wastewater reuse by industries (Azienda Po Sangone and CIDIU).

Full-scale agricultural reuse in Fasano, Apulia (Santoro et al., 2009)

Apulia is a south-eastern Italian region without permanent rivers or natural lakes, and whose groundwater quality is heavily jeopardized by salinisation due to seawater intrusion. The latter is caused by groundwater overexploitation by farmers.

The Fasano WWTP has an extensive water treatment storage capacity and it is directly connected to a 30 km distribution network. Since 2001, the Fasano tertiary treatment plant has been providing up to 8,000 m³ water/day to 51 farms, thus irrigating about 350 hectares of horticulture, intensive olive yards, and fruit trees.

The wastewater treatment plant located in Fasano (location Forcatella - 50,000 population equivalents (p.e.) has a treatment capacity of approximately 8,500 m³ of urban waste water per day. The treatment plant includes¹³⁷:

- activated sludge plant;
- more stringent treatments (capable of treating up to 2,800 m³/day) including: pre-disinfection with paracetic acid or sodium hypochlorite; coagulation-flocculation with aluminium chloride and slow sedimentation, post-disinfection with paracetic acid or sodium hypochlorite; and post-physical disinfection (optional) with UV light.

Information from the Environment Ministry:

Prato Province, Tuscany region¹³⁸

Prato Province has more than 300 textile industries. For the large industries only; the water need is about 12*10⁶ m³/year. There are 5 WTPs for urban, storm and industrial waste water. Treated wastewater from the main one, Baciacavallo TP, treating 35*10⁶ m³/ year is suitable for reuse (in line with the standards set out by the Italian regulation). The textile industry discharges very polluted water (contains TSS, pigments, chloride, etc.) and requires high level of treatment for reuse (i.e. 2/3 treated water has to be mixed with 1/3 freshwater to decrease salinity). The wastewater treatment system is equipped with specific finishing treatment plants to cope with the requirements set out by the users of the treated wastewater and some industries have their own ad hoc finishing treatment. The treated water cost is higher compared to groundwater but the tariff system encourages treated water reuse: the treatment cost is distributed among all the users and there are incentives to buy treated water. The number of textile industries is now decreasing so the treatment plant management is exploiting other treated water customers: fire contingency, large air-conditioning plants, car washers, building contractors, etc. The agricultural reuse is still difficult due to the high salt concentration in treated wastewater.

Venice Lagoon, Veneto region¹³⁹

On the edges of Venice Lagoon, a large industrial area has been supplied for decades with freshwater suitable for drinking water use. A large WTP was retrofitted and improved in order to:

- treat both industrial and urban wastewater and polluted groundwater;
- reuse urban treated water for industrial uses (75.000 m³/day in winter, 33.000 m³/day in summer) after a finishing treatment with constructed wetlands (150 hectares);
- discharge the remaining treated water to open sea (through a submerged pipe, 12 miles from the coast).

¹³⁷ http://www.unisco.it/website/inc/files/1301652812_441332.pdf

¹³⁸ <http://www.arpat.toscana.it/notizie/arpatnews/2010/035-10-il-riuso-delle-acque-reflue-realizzazioni-e-prospettive>

"Il riuso delle acque reflue, realizzazioni e prospettive", held in Florence on 1 February 2010 and in particular the paper Bassetti C., Borchi F., Caregnato F., Coppini E., Valeri R." Il riuso industriale: l'esperienza pratese"

¹³⁹ <http://www.regione.veneto.it/web/ambiente-e-territorio/progetto-integrato-fusina>

The project (called PIF, Integrated Fusina Project) was funded in project financing, by public funding and by a private company that will manage the WWTP.

Emilia Romagna Region

This region has a high water withdrawal:

- Agriculture: $1.385 \cdot 10^6 \text{ m}^3/\text{year}$ (64% of the total water abstraction);
- Civil: $489 \cdot 10^6 \text{ m}^3/\text{year}$ (23% of the total water abstraction);
- Industry: $278 \cdot 10^6 \text{ m}^3/\text{year}$ (13% of the total water abstraction)

All agglomerations have secondary treatment of their wastewaters. 24 WWTPs are suitable for being upgraded for water reuse, for a total volume of $560,000 \text{ m}^3/\text{d}$ and 2 million population equivalents (p.e.) (as mentioned in the Regional Water Protection Plan, 2006)¹⁴⁰:

Sardinia region¹⁴¹

In this island with semi-arid climate conditions, 34 WTPs are suitable for reuse (as of July 2011) corresponding to a total treated water volume of $150 \cdot 10^6 \text{ m}^3/\text{year}$, of which $114 \cdot 10^6 \text{ m}^3/\text{y}$ is already available for reuse (financed by the 2002 framework agreement). Examples of the main plants producing treated water already available: Cagliari Is Arenas (557.000 equivalent inhabitants), Cagliari Macchiareddu (297.000 equivalent inhabitants), Serramanna (200.000 equivalent inhabitants) e Sassari (180.000 equivalent inhabitants).

A site specific treated water reuse management plan is required by the regional water reuse regulation (deliberazione della Giunta regionale n. 75/15 del 30 dicembre 2008) for each treatment plant (or group of plants). The aim is to ensure the involvement of all the actors (wastewater management and end-users), by creating a consortium and by consulting with stakeholders and local authorities. The plan shall specify: the actors involved; the water quality and control protocols; the volumes of treated water; the monitoring program for soil, agriculture and the environment; the financial plan; the cost-effectiveness analysis; and contingency plans.

The region benefits from the following financial resources:

- EUR 5m (Structural Funds 2007/2013) for water saving by exploiting waste water reuse (public call for tender)
- EUR 1m in 2011 for compiling Water Reuse Management Plans
- EUR 6.5m for reuse in Cagliari (EUR 1.1m for treatment plant revamping + EUR 5.4m for the distribution system to public green areas).

Local examples include:

- The Villasimius Municipality: $1.075 \cdot 10^3 \text{ m}^3/\text{years}$ of treated waste water are reused for irrigation (both agricultural land and public green areas). A specific local regulation for reuse has been issued
- The Alghero Treatment Plant: $2.2 \cdot 10^6 \text{ m}^3$ of treated waste water have been reused since October 2011 for irrigation. A specific contract has been signed by the WTP manager and the local Irrigation Authority

¹⁴⁰ http://www.arpa.emr.it/documenti/arpavista/pdf2008n3/Berr%C3%A8AR3_08.pdf

¹⁴¹ <http://www.regione.sardegna.it/j/v/1725?s=1&v=9&c=389&c1=336&id=25435>
http://www.regione.sardegna.it/documenti/1_73_20090119163956.pdf

Latvia

Context

TYP SA, 2013:

Freshwater quality improvement and protection against eutrophication are among the main priorities in Latvia's environmental policy. To ensure its rational use and long-term protection, water has been defined as an important national asset. However, water reuse is not a high priority for Latvia.

Lithuania

Context

Angelakis et al., 2007:

By the end of 2004, the Lithuanian Water Suppliers' Association united 47 water utilities responsible for supplying and subsequent treatment of over 90 per cent of the gross volume of potable water in Lithuania. These water utilities have been treating approx. 98% of the wastewater disposed of in centralized systems, of which 90% is treated biologically. About 2/3 of the Lithuania's inhabitants make use of the services of centralized water supply and waste water treatment. As consumption of water shrinks, it is only a small percentage of the capacity of the treatment facilities, which is utilized.

To date, reuse of treated wastewater has not been developed and no instances of water reuse in industrial factories have been noted. Believably, it is only a small share of such wastewater which could be reused in auxiliary technology processes.

Information from the Environment Ministry:

Year	Wastewater discharged (Mm ³)
2006	164.9
2007	187.5
2008	175.0
2009	169.7
2010	181.5
2011	181.3
2012	179.5

Luxembourg

Context

TYP SA, 2013 (updated by the Water Agency of Luxembourg):

National consumption of drinking water corresponds in average to +/- 220 L/capita/day. However, the average drinking water consumption in a Luxembourgish household is lower and corresponds approximately to 137 L/capita/day. In contrast to the average private consumption, the higher value corresponds to the average overall consumption of drinking water [in L/capita/day]. This value does not only include the amount of drinking water consumed by private households but also the consumption by companies such as bakeries or supermarkets as well as industries and farms connected to the public drinking water distribution network. In addition to this, the circa 150.000 commuters (which corresponds to approximately 30% of the total population of Luxembourg) who work in Luxembourg and contribute to the consumption of drinking water but are not included in the calculation of average consumption as their residence is not located in Luxembourg therefore also contribute to the higher value of +/- 220 L/capita/day.

Angelakis et al., 2007

Industry needs 25%, agriculture 30% and households 45%. Today, surface water covers about 1/3 of the average water consumption and up to 2/3 of the summer peaks.

Water reuse practices

Angelakis et al., 2007 (updated by the Water Agency of Luxembourg):

As Luxembourg has no real problem in providing fresh drinking water, wastewater reuse does not rank high on the agenda of the country. There is greater emphasis on rainwater harvesting. Nevertheless, in order to protect its watercourses especially in summer, when the levels are low, some provisions have been made: industry generally is encouraged to recycle process and cooling water. The use of treated wastewater is being considered for humidification in the compost industry.

Malta

Context

Angelakis et al., 2007:

The water deficit in Malta is acute. Wastewater reuse for irrigation has been contemplated as early as 1884 in order to preserve freshwater for domestic use.

Water reuse practices

Information from the Environment Ministry:

The treatment of sewage effluents for re-use in the Maltese Islands was started in 1983 with the commissioning of the Sant' Antnin Waste Water Treatment Plant. The scope behind the development of this treatment plant was the creation of a new supply of water for agricultural and industrial concerns located in the South-Eastern region of the islands. The plant was initially designed to treat 7,000 m³ of sewage per day but was eventually upgraded in 1993 to treat 10,000 m³/day. In fact, the plant managed to augment the irrigated area in the South-Eastern region of the islands by around 500 ha, in an area which traditionally had always been under

dry-land cultivation. The main problems associated with the operation of the Sant' Antnin Plant are related to:

- The relatively high salinity (peaking at 10,000 $\mu\text{S}/\text{cm}$) of the treated effluent, a direct consequence of the high salinity of sewage in the islands. This saline content arises from the direct infiltration of sea-water in the sewerage network in those areas where the sewers are located below sea-level and the (illegal) discharge of brines in the sewerage network; and
- The traditional open channel distribution system adopted at the time which was prone to high levels of water theft and did not allow the establishment of an effective control on the distribution of the treated effluent.

In 2006, only about 12% of all wastewater was treated. The implementation of the UWWT Directive has seen the commissioning in recent years of three new WWTPs, which together have the capability of treating all the wastewater produced in the Maltese islands prior to its discharge to the sea. These treatment plants are:

- The Ras il-Hobz (Gozo) WWTP commissioned in 2008, with a potential production capacity for 6,000 m^3 of treated sewage effluent per day;
- The Cumnija (Malta North) WWTP commissioned in 2009, with a potential production capacity of 8000 m^3 of treated sewage effluent per day; and
- The Ta' Barkat (Malta South) WWTP commissioned in 2011, with a potential production capacity of 60,000 m^3 of treated sewage effluent per day.

Due to the persisting problems associated with the high salinity of the treated effluent, new polishing facilities (ultra-filtration followed by brackish water desalination) are being developed. In fact, the current plans to enable the effective utilisation of polished wastewater as a new resource of water include:

- Three polishing plants for treated wastewater located at the wastewater treatment plants initially producing 3,200 m^3/day , 6,400 m^3/day and 9,600 m^3/day of polished effluent at the Gozo, Malta North and Malta South plants respectively (this represents a total production of polished water of approximately 7 million m^3/y). A modular approach will be adopted in the development of these polishing facilities to enable the comprehensive review of the impacts of reductions in the saline content of the treated effluent achieved through the below quoted actions on the treatment needs required;
- The upgrading and rehabilitation of the sewerage network, particularly in those areas where the network is located below sea-level to reduce the direct intrusion of sea-water in the network;
- Continuous improvements to the existing regulatory structure to monitor discharges to the sewerage network with the aim of reducing both the discharges of brines and also of industrial and other organic contaminants; and
- The development of dedicated second class water distribution system to deliver the polished effluent at the point of use.

These measures all fall under the framework of the National Water Management Plan which is currently being developed in the Maltese islands. This plan will seek the integrated use of water supply augmentation and water demand management measures to address the islands' chronic water scarcity conditions. It is further noted that under this management plan, the utilisation of

polished treated effluents will be considered for a wide range of uses including the managed artificial recharge of aquifer systems.

Angelakis et al., 2007:

In 1986, the possibility of industrial wastewater reuse was considered. There are two large industrial water consumers on Malta: Enemalta, a thermal power plant and Malta Drydocks, a shipyard. In the thermal power plant, 1,150 m³/d of demineralized water are needed for boiler feed make-up (de Ketelaere, 2001). The use of the recycled water for industrial purposes depends primarily on the economic circumstances, namely on the comparison of the total costs of recycled water with other sources of water such as desalinated seawater. In 2007, recycled water was only used in industrial laundry.

Netherlands

Context

Angelakis et al., 2007 (updated by the Environment Ministry):

Overall the Netherlands is a water abundant country, without a significant water shortage. Water scarcity may sometimes occur in specific areas. Some regions (mostly groundwater dependent terrestrial ecosystems in the south-west, east and north-east of the country) can experience water shortages during dry spells.

Water reuse practices

Angelakis et al., 2007 (updated by the Environment Ministry):

Reuse of water for irrigation is only possible when the quality of the water is sufficient: for crop irrigation, chlorine and iron are the limiting substances at present. The bacteriological quality of the water is mostly too poor to meet the standards for drinking water for cattle and for bathing waters. Reuse of wastewater can be a good option for certain industrial applications such as cooling systems, water for cleaning, etc.

So far, the total amount of wastewater recycling and reuse in the Netherlands is small. However there are quite a few innovative (pilot) projects ongoing. In a few cases, recycled water is used for maintenance of the aquifer water level, industrial uses and urban uses. The use of recycled water depends on the local situation: availability of “good-quality” reclaimed water at a “competitive” distance, compared to surface water. In the near future, reuse will probably increase. Water reuse for industry in order to substitute drinking water prepared from groundwater is for example used by water and wastewater companies in Tilburg (Maas, 2003)¹⁴². For industries, water recycling is an option if it is cost-efficient. For example, DOW Chemicals in Terneuzen has recycled its own effluents for many years and since 2007 it has also used treated urban wastewater from a treatment plan of the city Terneuzen. The long-range perspective foresees wider uptake of industrial water reuse practices. The infiltration and the use for irrigation are additional options.

In agriculture, wastewater will be stored and even treated to meet the standards required for this purpose. Water boards are also considering an additional treatment (sand filtration) after tertiary

¹⁴² Maas, J. Flowing together (Samen stromen B.V.) An example of sound ownership and financial practice, Proceedings of AQUAREC International Workshop on Implementation and Operation of Municipal Wastewater Reuse Plants, Thessaloniki, Greece 11-12 March 2004

treatment if the wastewater can be used for groundwater recharge in forest areas or other natural areas.

Poland

Context

Angelakis et al., 2007:

Water supply and sewage disposal conducted in Poland aims at both decrease of consumption of water resources and reduction of water environmental impact of sewage through reducing of the amount of sewage and pollutant load, eliminating environmentally dangerous substances from sewage, application of closed circuits and water reuse as well as wastewater treatment before its discharge into the environment. According to the Ministry of Environment report, presenting the implementation of the KPOSK, before the end of 2005, 323 investments were implemented and 63 of them were postponed for the next years.

Portugal

Context

Angelakis et al., 2007 (updated by the Environment Ministry):

In spite of the fact that Portugal is not bathed by the Mediterranean Sea, the Portuguese climate presents some features of Mediterranean climate particularly in the half of the country south of river Tagus. Recurrent droughts severely affect the southern Portugal. Due to its climate, mainly in the southern part, Portugal has intermittent rivers, because of low precipitation during several months. The natural surface water flow regime would not allow for basic population supply, in some areas. The way the society is structured nowadays relies on a significant storage capacity. The natural regime itself has no longer a real meaning, in what concerns water uses fulfilment.

Water reuse practices

Angelakis et al., 2007 (updated by the Environment Ministry):

In Portugal, treated wastewater is a valuable potential resource for irrigation road construction and car washing. The volume of treated wastewater available today in Portugal exceeds 480 Mm³/yr. Even without storage, this amount could be enough to cover about 10% of the water needs for irrigation in a dry year. The use of treated wastewater for irrigation could significantly contribute to the agricultural development in the driest Portuguese provinces (Algarve, Beja, Evora, Setubal, Lisboa and Santarem). Roughly, between 35,000 and 100,000 ha, depending on storage capacity could be irrigated with treated wastewater.

A significant percentage (around 65-70%) of overall national water used is taken by agriculture. In years of mean annual precipitation, the availability of water is enough to fulfil agriculture requirements along with other uses but, during droughts periods, the water scarcity greatly affects the agriculture sector, mainly in the south. Therefore, the water re-use is being considered as an interesting option to fulfil some availability gaps, along with an increasingly awareness of the need to reduce water's pressure.

In 2011, only 6.1 Mm³ were re-used. Around 89% of this volume was reused by the water treatment companies, for internal uses, and only about 11% were supplied to other entities (ERSAR, 2012).

Many different applications exist, such as: irrigation of agriculture and landscapes, toilet flushing (buildings equipped with dual systems), dust control in public construction projects, and water for air conditioning (IKEA). Quantities reused remain however very low for each of these applications.

Romania

Context

TYPSA, 2013 (updated by the Environment Ministry):

Romania's water resources present a particular feature: 97.8 % of the rivers are collected by the Danube which flows for 1 075 km over Romanian territory or along the national border, out of its total length of 2,860 km. The long-term annual average (LTAA) available theoretical (potential) freshwater resource is 125 billion m³, of which 40 billion m³ are in interior rivers and 85 billion are the Romanian share of the average annual flow of the Danube, plus an annual available groundwater resource estimated at 9.6 billion m³. Consequently, the specific theoretical water resources in natural regime, including the Danube, amount to 6,400 m³ per person per year, but considering the river basins development level, the specific usable water resources is about 1,870 m³/person/year.

Treated wastewater reuse has not been used since now due to the existing of sufficient water resources comparing with the water resources demand (requirement for specific uses), and also due to reduction of water demand for economic activities and population (water saving measures, water metering, lack of functional irrigation systems, etc.).

Information from the Environment Ministry:

Concerning the volumes of wastewater collected in Romania in 2012:

- The total volume of collected wastewater was 4,985 Mm³, out of which 2,198 Mm³ (44%) wastewater that needed to be treated; and
- Out of the volume of 2,198 Mm³ wastewater: 560 Mm³ (25.5%) were treated, 819 Mm³ (37.3%) were insufficiently treated and 819 Mm³ (37.2%) remained untreated.

Slovakia

Context

Angelakis et al., 2007 (updated by the Environment Ministry):

Slovakia has a mean long-term rainfall about 762 mm – what represents approximately 37.35 billion m³ per year. Average water abstraction amounts to 665.0 million m³ per year (5.3% of rainfall), out of it 388.0 million m³ for drinking uses and 277.0 million m³ for other uses. Abstractions from groundwater represent 51.0 % and withdrawals from surface water 49.0 %. Average total drinking water consumption is about 178 l/inh./day, by households only 80.8 l/inh./day.

Rainfall and runoff in Slovakia are unevenly distributed. The available quantity of water is not considered as a total average rainfall, but surface water and underground resources with high probability (95 % and above) - that is not the average yield and flow. Available quantity of surface flows stemming in Slovakia represents only about 80 m³/s, compared with an average long-term flow of 398 m³/s. Surface resources are utilized to 12.9 % and underground sources

to 14.2 %. After deduction of ecological limits, (which must remain in streams) of water resources is the use of natural sources of water approximately doubled (from 25 to 30 %).

Due to the abundant water resources, water reuse in Slovakia has not received much attention and it occurs mostly in industry. The reuse of wastewater is only recommended where it contributes to reducing pollution and/or costs, but it could become more relevant in the future due to climate change. The basic goal of water protection in Slovakia is to make rationale use of water and to minimise material flows to the receiving waters. Source control of water pollution has a high priority.

Slovenia

Water reuse practices

Angelakis et al., 2007:

Development of treatment technologies for various types of wastewater by constructed wetlands has recently started. One of the priorities of the constructed wetlands technology is water recycling and reuse. Unfortunately, so far the constructed wetlands have only been used for small communities and consequently rather limited amounts of water to be recycled are generated. It is expected that, in the very near future, technology including water recycling and reuse will be used widely and mainly in touristic areas. Some relevant projects have been already implemented (Vrhovšek, 2002).

Spain

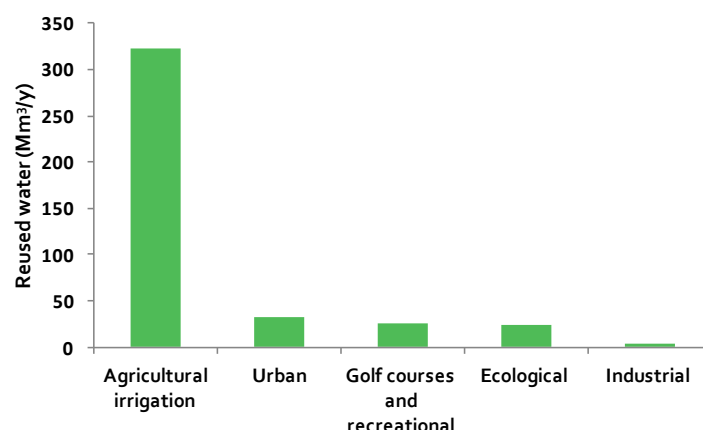
Water reuse practices

TYPSA, 2013:

The reuse of treated wastewater is already a reality in several Spanish regions for four main applications: golf course irrigation, agricultural irrigation, groundwater recharge (in particular to stop saltwater intrusion in coastal aquifers) and river flow augmentation (Angelakis et al., 2007).

Irrigation is the dominant application of reclaimed water (Figure 11).

Figure 11: Volume of wastewater used by sector in Spain in 2004 (adapted from TYPSA, 2013)



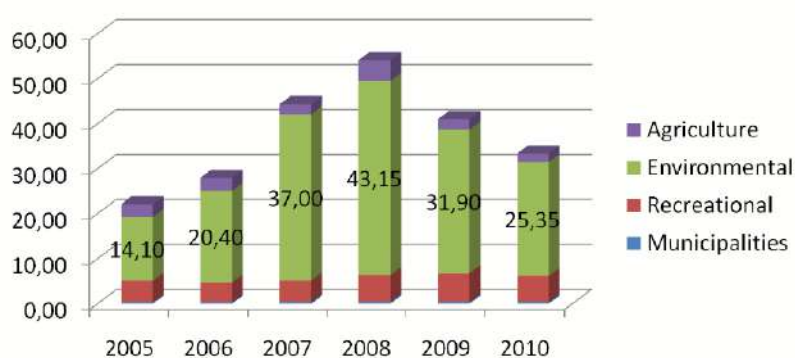
Commercial interest exists and some private water companies invest in Research and Development activities, in collaboration with the Universities (Angelakis et al., 2007). Multiple projects have been implemented treating brackish wastewater for irrigation and seawater desalination for irrigation in water short regions (Angelakis et al., 2007).

In the past, and in some places up to this day, wastewater was used raw for agricultural irrigation. The progressive implementation of the UWWTD is decreasing the availability of raw wastewater and increasing the volume of treated effluent to be disposed of.

Because of the lack of rain during several months every year, the flow of rivers on the Mediterranean coastline essentially consists of treated or untreated wastewater. Increases in wastewater reclamation and reuse could therefore severely reduce flows particularly during peak demand periods, leading to environmental problems. However, there is still scope for further implementation of water reclamation schemes in Spain to support irrigated agriculture. Its development is, however, strongly correlated to drought episodes, usually occurring every 5 to 15 years and mobilising the public opinion.

In Catalonia, and especially in the highly touristic Costa Brava area, reclaimed water is primarily used for environmental and recreational uses (see the figure below).

Figure 12: Reclaimed water applications in Catalonia (Mm^3/y) (Escudero, 2011)



Source: ACA

Information from the Environment Ministry:

The volume of treated urban wastewater produced in Spain was around $3,375 \text{ Mm}^3$ in 2006 and it is increasing. The volume of treated wastewater reused in Spain was around 430 Mm^3 in 2009 and it is increasing.

There are many advanced reuse water schemes in regions like Cataluña, Murcia, Madrid or Andalucía, where the reclaimed water is destined for multiple uses: parks, gardens, recovery of wetlands, golf courses, agricultural irrigation or industrial uses, etc. In some of these schemes, the use of reclaimed water is an obligation for specific uses.

Information from the Catalan Water Agency website¹⁴³

The Catalan Water Agency (ACA) works to develop and implement different reuse actions, with an investment of EUR 330m, which over the coming years will help to improve the availability of resources and meet the requirements of the Water Framework Directive. Catalan treatment plants treat approximately 700 million m^3 of water every year. The works carried out by the water administration of Catalonia demonstrate a progressive increase in the percentage of

¹⁴³ http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P17201098371242992668319&profileLocale=en (accessed 28.08.14)

reused water derived from the treated wastewater of WWTPs. With the actions being undertaken and planned for over the coming years, the ACA intends to reach the goal of 200 million m³ of reused water by 2015, which would mean that 31% of treated water would be reused.

Examples of reuse schemes

Closure of coastal water cycle in Costa Brava (Sala, 2011; Sala, 2004; Mujeriego, 2007)

Consorci de la Costa Brava, the Water Agency created in 1971 by the 27 municipalities of the coastal area of Girona's province, is responsible for water resource management in the whole area.

Since 1989, reclaimed wastewater has become an additional water resource on the Costa Brava for non-potable purposes, with 6.4 million m³/year produced in 14 facilities in 2010. Recycled water supplies large irrigation users (i.e. golf courses) as well as municipalities. Reclaimed water is also used for aquifer recharge and environmental reuse.

Reliability of reclamation treatments in Costa Brava has improved with time, especially in the case of disinfection processes. In the future, the Water Agency intends to improve the scheme so as to distribute reclaimed water to private users through municipal networks and to better recharge aquifers.

Involvement of local NGOs and environmental associations was identified as a key success factor in the implementation of these reuse schemes.

Irrigation with reclaimed water in the Júcar and Segura Basins (Iglesias and Ortega, 2008)

The water reused in the Júcar and Segura Basins in 2004 was around 234,000 m³/year, which amounts to approximately 57% of the water reused in the whole of Spain at that time. About 98% of this volume was used in irrigation. In both regions, the characteristic features of irrigation are the predominance of small holdings, the wide variety of crops grown in one single irrigation zone, and the presence of irrigation channels and drainage ditches where the regenerated water is mixed with water from other sources.

Water reuse in the Holmen paper mill, Madrid

The paper mill completely covers its water demand by reclaimed effluent from the Arroyo Culebro municipal WWTP.

The El Prat de Llobregat water reclamation plant (WRP) reuse scheme, Barcelona region

The scheme combines aquifer recharge, wetlands maintenance, agricultural irrigation, maintenance of the Llobregat River ecological flow, and urban and industrial applications.

The water treated by this process is used in applications such as ecological flow maintenance or wetlands conservation. For other applications which require further treatment (i.e. direct injection into the Llobregat Delta aquifer and agricultural irrigation), there are two advanced reclamation plants.

Sweden

Context

TYPSA, 2013:

In spite of its high availability of water resources and a low rate of abstraction of renewable water resources (just 2%), in the south eastern region of Sweden there is an interest for reusing the tertiary treated effluents of WWTP for irrigation. The reason for this practice reuse is that it contributes to preserve coastal receiving waters and to conserve groundwater for nobler uses.

Water reuse practices

Angelakis et al., 2007:

In areas where water is scarce, especially for irrigation, wastewater is considered as an obvious resource. In Sweden, wastewater has been collected in large reservoirs for up to nine months before irrigation. The benefits with these projects have been mainly twofold: (a) Wastewater treatment in a safe and financially attractive way and (b) creation of water resources for agricultural irrigation. These schemes have meant that wastewater treatment is handled in a cheap but very efficient way. Nutrients in the wastewater are recycled to farmland and the farmers are provided with cheap irrigation water. It is profitable for the Water Utility since it is selling water instead of constructing and operating expensive sewage treatment plants; and for the farmers because they secure and increase their harvests and they can also buy water cheaper than had been able to do, if they had constructed their own irrigation systems. This is also an ecological solution that avoids all discharges of more or less treated sewage water.

Examples of reuse schemes

TYPSA, 2013:

There are over 40 reuse projects consisting of effluent storage up to 9 months in large reservoirs before being used for irrigation. In some cases the effluent is blended with surface water.

Information from the Swedish Water and Wastewater Association (SWWA):

On the island Gotland, municipal sewage water from 900 inhabitants is reused for agricultural irrigation. The amount of water is approximately 2.5 % of the total municipal sewage produced on the island of Gotland. The island Gotland is a part of south east Sweden where the annual precipitation is low (200-300 mm/year).

United Kingdom

Water reuse practices

Angelakis et al., 2007:

The UK has used treated wastewater to maintain river flows (and ecosystems) and through river abstractions to contribute towards potable water and other supplies. This practice is particularly developed for the major rivers in the South and East where it is not always feasible to abstract upstream of treated wastewater discharges to surface water. This enables the London region to operate with a water availability of 265m³/person/year.

Besides this indirect reuse, there are some examples of direct treated wastewater reuse, mainly for irrigation purposes (golf courses, parks, road verges), but also for business uses such as

process water for power generation (Flag Fenn), car washing, cooling, and fish farming. There are many industrial projects where the wastewater from the manufacturing site is being reused, thereby recovering heat and reducing potable and wastewater treatment costs. These projects cover food, aerospace, paper and other industries.

Overall, there is no consistent or extensive pattern of treated wastewater reuse in the UK. Historically, there has been sufficient water to meet demand, so relatively few schemes for reuse have been developed. The projects implemented have been complicated due to lack of clear guideline on ownership of the wastewater, and of agreed quality issues. Information and guidance notes on the installation, modification and maintenance of reclaimed water systems and pipework was published by the Water Regulations Advisory Scheme in August 1999 (WRAS)¹⁴⁴.

After the droughts of the last few years, these are expected to increase significantly with considerable public, political and climatic pressure in the UK to use water wisely, subject to appropriate assurances about quality and costs. Water UK research group UKWIR with AWWA and Water Reuse Foundation published in 2005 a “Framework for developing water reuse criteria with reference to drinking water supplies” as an aid to the decision making process and to identify the factors that need to be taken into account when planning and implementing a water reuse project.

Information from the Environment Ministry:

There is not a lot of water reuse in the UK at the moment. UKWIR are currently undertaking a project ‘Establishing a Robust Case for Water Reuse’ which is due to complete in the in the first quarter of next year. This should provide information on regulatory barriers to increased reuse in the UK.

Examples of reuse schemes

Langford recycling scheme¹⁴⁵

Since 2003, the Langford recycling scheme, operated by Essex and Suffolk Water, provides 25 M litres/day of reclaimed wastewater that is discharged to the river and then abstracted to augment the Hanningfield freshwater catchment reservoir prior to treatment for potable water production. This was the first example of a planned indirect potable reuse scheme in Europe.

Old Ford Water Recycling Plant¹⁴⁶

The Old Ford Water Recycling Plant, located next to the main site of the London 2012 Olympic and Paralympic Games, is the UK’s largest community wastewater recycling scheme.

It treats wastewater from the Northern Outfall Sewer and feeds in to a non-potable network that connects to the Olympic Park for toilet flushing and irrigation. Water reuse contributed to achieving the water consumption objectives of Olympics and turned out to be an important asset following the drought of Spring 2012 (which led to a temporary ban on irrigation water).

The reclaimed water is charged 10% less than potable water.

¹⁴⁴ WRAS, Water regulation advisory scheme Reclaimed water systems. Information about modifying or maintaining reclaimed water systems No 9-02-04. Marking and identification of pipework for reclaimed (greywater) systems. No 9-02-05 www.wras.co.uk

¹⁴⁵ <http://www.reclaimedwater.net/data/files/252.pdf>

¹⁴⁶ <http://learninglegacy.independent.gov.uk/documents/pdfs/sustainability/old-ford-case-study.pdf>

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ANNEX B: Comparison of water reuse standards in the EU Member States and in selected non-EU countries

The main purpose of this annex is to enable an overall comparison of key existing standards on water reuse and to inform the design of policy options at the EU level.

The following standards have been reviewed:

- Existing standards in the EU Member States (CY, ES, FR, EL, IT, PT)
- A selection of widely used standards developed by non-EU countries and international organisations (Australia, California¹⁴⁷, UNEP (Mediterranean Region), USEPA and WHO).

In addition, preliminary information on the development of the **ISO standards** has been reviewed, and a summary is provided at the end of this document.

The term 'standard' used in this report refers to different types of documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that water reuse projects achieve an acceptable level of health and/or environmental protection.

It is important to note that standards are only one type of the policy instruments that can be used to govern the reuse of wastewater. Among the six EU Member States that have developed water reuse standards, some have other policy instruments in place (legislative and/or non-legislative) to regulate and/or promote water reuse (see Annex E for further details on the other policy instruments). Additionally, in many Member States water reuse projects may be governed by legislation that is not specific to water reuse; in particular, water reuse projects may be subject to permitting processes under national regulations (e.g. on wastewater discharge, on drinking water), with specific operating conditions imposed by the permits including risk management measures and/or limit values for certain parameters (e.g. BE, DE, UK).

Another important point to note is that the standards that are the most directly comparable to the EU context, in terms of geographical scope and governmental arrangements, are the ones developed by the USEPA and Australia. Both are in the form of guidelines recommended at the federal level, which can be used as a basis for the development of a policy framework at the state level.

¹⁴⁷ Chosen as a well-known example of standards established within a US state; however, several other US states have established water reuse standards (e.g. Arizona, Florida).

The comparison of the standards is based on the following criteria:

- Legal status
- Type(s) of wastewater covered (urban, industrial, etc.)
- Reuse categories covered
- Approach followed
- Number of parameters
- Types of parameters
- Monitoring requirements/recommendations
- Additional risk management measures required/recommended
- Possible requirements related to the granting of permits for water reuse

For each standard reviewed, a factsheet summarises the specifications in relation to each of the above criteria. The information mainly comes from a review of publicly available literature, complemented by information provided by some of the Member States (questionnaire replies). In a second stage, information related to each criteria has been compared across the different standards. The key findings of this comparison are presented below.

Legal status of the standards

In all the EU MS where standards exist, they have a legally-binding status, except in PT. In PT, however, water reuse permit conditions (which are legally-binding) are based on the standards. Among the non-EU standards reviewed, only Californian standards have a legally-binding status; other standards reviewed have a guidance status.

Types of wastewater

All the standards reviewed cover treated wastewater from municipal WWTPs. In two EU MS (EL and IT), industrial wastewater is also expressly covered. The Australian standards also cover greywater and stormwater¹⁴⁸.

Use categories and restrictions

Each standard specifies which uses are covered. These different uses may then be grouped into wider categories. Although there are similarities between the uses and categories covered by the different standards, they never match perfectly (definitions for these categories are not homogeneous). Most importantly, the number of categories varies significantly; for example, IT has only defined 3 use types while ES has 24 use types grouped into 14 categories and California has 47 use types grouped into 4 categories.

An overview of the main application areas covered by the standards is provided in Table 10, while typical examples of uses covered by each area are listed in Table 11.

¹⁴⁸ Greywater being defined as wastewater from kitchen, laundry and bathroom drains (but not from toilets). Stormwater being defined as rain draining into the stormwater system from roofs, roads, footpaths and other ground surfaces.

Table 10: Main application areas covered by the standards

Standards reviewed	Main application areas						
	Agriculture	Green areas & recreational	Environment	Urban	Domestic	Industry	Drinking water
EU Member States							
Cyprus	X	X	X				
France	X	X					
Greece	X	X	X	X	?	X	
Italy	X	X		X		X	
Portugal	X	X	X	X	X	X	
Spain	X	X	X	X	X	X	
Outside the EU							
Australia	X	X	X	X	X	X	X
California	X	X	X	X	X	X	
UNEP – Mediterranean Region	X	X		X	X	X	
USEPA	X	X	X	X		X	X
WHO	X*						

*The WHO standards also cover aquaculture

Table 11: Typical examples of uses for the main application areas

Main application areas	Typical examples of uses included in the category*
Agriculture	Food crops intended for human consumption, to be eaten raw Food crops intended for human consumption, industrially processed Industrial crops non intended for human consumption Grassland irrigation Forest exploitation
Green areas & recreational	Irrigation of green areas, golf courses, sport lawns Ponds, ornamental fountains, cascades Artificial snow for commercial outdoor use
Environment	Aquifer recharge Augmentation of surface water Wetlands
Urban	Streets and roads cleaning Car washing Fire fighting Ornamental fountains Cooling water for air conditioning
Domestic	Flushing toilets and urinals Laundries
Industry	Cooling towers and evaporative condensers Water for industrial processes or cleaning
Drinking water	Indirect reuse through augmentation of surface water Direct reuse

*These are only examples; not all these uses may be covered by the standards, under each application area.

In addition, in three EU MS the standards specify some **prohibited uses**:

- In CY: irrigation of leafy vegetables, bulbs or tubers that are eaten raw
- In ES: water intended for human consumption (except in catastrophe situation), use in hospitals, bathing water, fountain or ornamental products in public spaces, and all other uses presenting health risks
- In FR: irrigation with raw sewage, irrigation with treated wastewater from WWTPs connected to certain animal by-products processing installations, irrigation with treated wastewater from WWTPs whose sewage sludge do not comply with applicable limit values, irrigation with treated wastewater on soils that do not comply with limit values specified by the national legislation on agricultural use of sewage sludge, irrigation with treated wastewater within the close protection perimeters of drinking water abstraction points (with some exceptions).

Approach

Three main types of approaches can be distinguished:

1/ An approach based on **limit values** defined for a range of parameters of the reclaimed water

By complying with these numerical limit values, health and/or environmental risks are deemed to be minimised. The limit values may be applicable at different points, depending on the standards (e.g. at the reclaimed water delivery point or at the outlet of the WWTP).

This approach is the one followed in the six EU MS reviewed. Specificities in two MS are worth being noted:

- In CY, requirements on water reuse are part of the municipal wastewater treatment regulations (as almost 100% of treated sewage is reused).
- In FR, requirements on water reuse are strongly linked with the national legislation on the agricultural spreading of sewage sludge: not only the quality of the reclaimed water shall be monitored, but also the quality of the sewage sludge produced by the WWTP and the quality of the agricultural soils.

2 / An approach based on wastewater treatment requirements and limit values

This approach is the one adopted by California (Title 22 of the Code of Regulations). For each potential use, a specific wastewater treatment technique is required. California has a system for approving and certifying treatment technologies under Title 22. In addition, for certain use categories, water quality criteria can apply (numerical limit values).

The USEPA guidelines also follow this type of approach.

3 / An approach based on the implementation of a risk management system for each reuse project

This approach is the one adopted by the Australian and the WHO guidelines.

An advantage of this approach is that it involves identifying and managing risks in a more proactive way, rather than relying on post-treatment testing and reacting when problems arise. It is also more flexible as it may be applied to a wide range of situations. First, the main health and environmental risks need to be identified and assessed, then measures to prevent and control the risks have to be implemented, followed by the implementation of monitoring procedures to check the risks are effectively reduced to an acceptably low level.

The Australian guidelines specify the log removals of enteric pathogens for different treatment processes as well as the required log reductions for water reuse categories. The guidelines also provide an indicative list of parameters that may be relevant for monitoring.

The Australian guidelines for drinking water augmentation and the WHO guidelines recommend the definition of health-based targets to manage health risks. Such targets measure the gap between current health status and an ideal health situation using DALY per year and per person units (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life). The guidelines also provide an indicative list of parameters for the validation, operational and monitoring stages of the water reuse scheme.

Parameters and limit values

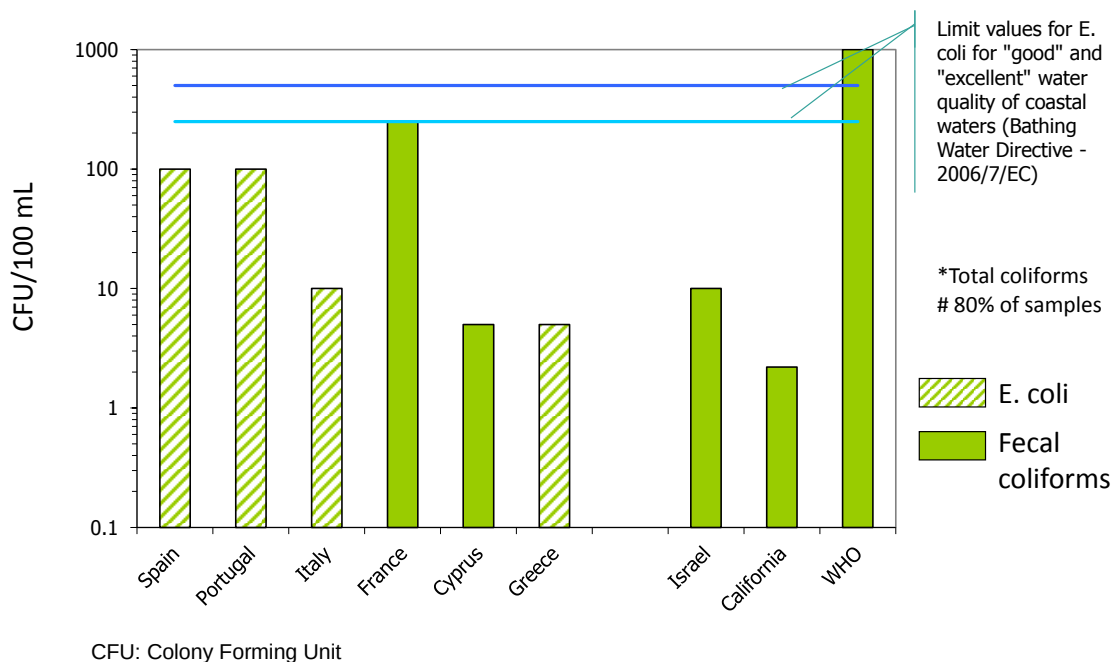
There are large disparities in the number of parameters associated with limit values (where they exist). For example, while FR defines 6 water quality parameters, IT defines 55 parameters, EL has up to 80 parameters and ES up to 90 parameters. In a country like Spain, monitoring costs can therefore become significant for water reuse scheme operators as well as competent authorities in charge health and environmental inspections.

In addition to significant differences observed between the EU MS, different limit values may apply within the same country. In IT, regional authorities are allowed to set more stringent limit values than those mentioned in the Decree; as a result, in Emilia Romagna and Puglia regions, microbiological quality criteria are similar to those of the California Title 22 guidelines while in Sicily they are similar to those of the WHO guidelines.

In FR, as already mentioned, not only the quality of the reclaimed water shall be monitored, but also the quality of the sewage sludge produced by the WWTP and the quality of the agricultural soils. Compliance is checked against the limit values specified by the national legislation on agricultural spreading of sewage sludge.

Because the reuse categories are not defined the same way across the standards reviewed, it is of limited relevance to try and compare the individual numerical limit values specified by each standard. As an example, a comparison carried out by EUREAU on limit values for *E. coli* and faecal coliforms applicable to unrestricted irrigation is shown in the figure below.

Figure 13: Comparison of limit values for *E. coli* and faecal coliforms applicable to unrestricted irrigation using reclaimed water (Source: EUREAU, 2013)



A recent French study pointed out that countries which recycle the largest volumes of treated wastewater are also those which have the lowest number of mandatory quality criteria and the easiest parameters to monitor (French Environment Ministry, 2014). The study takes Israël and Italy as two extreme examples: Israël is recognised as a leader in water reuse and has defined less than a dozen of parameters, while Italy has defined more than 50 parameters but only recycles a small proportion of its wastewater.

Monitoring

Most of the standards require or recommend minimum frequencies for sampling and analysis of the reclaimed water.

Depending on the standards, water samples may be taken from different points (e.g. outlet of WWTP, reclaimed water delivery point).

Responsibilities for water quality monitoring and the possible communication of monitoring results are defined in different manners in the standards. Depending on the standards, responsibilities fall on the WWTP operator and/or the reclaimed water network operator and/or the final user. Because monitoring can be quite costly, these determinations of responsibility can have significant implications for the implementation of the standards.

In FR, the monitoring also covers the accumulation of contaminants in the sewage sludge produced by the WWTP (at least 4 times/year) and in agricultural soils (every 10 years). Sewage sludge quality is monitored because it is considered as a reliable indicator of the overall WWTP efficiency with regard to the removal of pathogens and other hazardous substances.

Application controls

A majority of standards require or recommend application control measures. They relate to the manner in which the recycled water is used. The main types of measures encountered are as follows:

- Adequate design to avoid cross contamination risks between the reclaimed water network and the drinking water network (e.g. no cross section with potable water pipes, setback distances)
- Clear signalling of the various elements of the reclaimed water distribution network in order to avoid confusion with the drinking water network
- Restrictions on crop types to be irrigated
- Setback distances between areas irrigated with treated wastewater and specific sensitive areas (e.g. drinking water supply wells), protection with tree curtains in the case of spray irrigation
- Access restrictions for the public and for animals (e.g. milking animals)
- Selected methods of application (e.g. spray irrigation forbidden)
- Time schedule of irrigation sessions (e.g. irrigation at night, irrigation to be ceased a certain period of time before harvest)
- Assessment of suitability of climate conditions (e.g. maximum wind speed above which spray irrigation is forbidden)
- Assessment of land plot suitability (e.g. maximum authorised land slope)
- Provision of protective equipment for irrigation operators
- Awareness raising and training measures for the operators, end users and community stakeholders
- Emergency storage or disposal provisions of untreated or partially treated wastewater to be provided in the case of treatment process failure.

Permitting system

In EU MS where standards are in place, there are also associated permitting processes for water reuse schemes. Permit application requirements are either specified by the water reuse standards, or they are set by other national regulations (e.g. on wastewater discharge).

Existing standards in the EU Member States

Cyprus	
Reference documents	- State Law N.106(I)/2002 (amendments 2002-2009) concerning 'The Control of the Waters Pollution' and associated regulations K.D.P. 407/2002, 772/2003, 254/2003 and 269/2005 - Code of Good Agriculture Practice, 2007 (regulation K.D.P. 407/2002) (http://faolex.fao.org/cgi-bin/faolex.exe?rec_id=075491&database=faolex&search_type=link&table=result&lang=eng&format_name=@ERALL)
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Treated municipal wastewater - obligation for a tertiary treatment NB: The laws also cover municipal sewage sludge
Potential uses and restrictions	<u>Water pollution control law:</u> 6 potential uses: - crops and green areas with restricted use - green areas and vegetables eaten cooked - green areas with restricted public access - fodder crops - industrial crops - aquifer recharge (?) <u>Code of Good Agriculture Practice:</u> 6 potential uses: - irrigation of green areas - irrigation of agricultural crops, forage crops, and green spaces with limited access to the public - irrigation of vineyards - orchards irrigation - vegetables eaten cooked - vegetables eaten raw It is forbidden to irrigate leafy vegetables, bulbs or tubers that are eaten raw with reclaimed water.

Cyprus

Approach	In Cyprus, water reuse provisions are fully integrated into the legislation on urban wastewater treatment and discharge. In general, all treated wastewater produced in Cyprus is reused, primarily for the irrigation of agricultural land, parks, gardens and public greens, where the Code for Good Agricultural Practice (K.D.P. 407/2002) is applied. The management of treated wastewater is implemented through a permitting and inspection system under the Water Pollution Control Law as well as Regulations and Ministerial Decrees. Waste Discharge Permits are issued by the Minister of Agriculture, Rural Development and Environment. The quality requirements as well as the crops irrigated are defined in the permit, having considered the provisions of the Code of Good Agriculture Practice Decree. <u>Water pollution control law:</u> Numerical limit values are set for a range of parameters. They apply at the WWTP outlet. These values are different depending on the size of the WWTP (WWTPs serving urban and rural agglomeration above 2,000 population equivalent (p.e.) or below 2,000 p.e.) <u>Code of Good Agriculture Practice:</u> For each potential use, irrigation methods are indicated.
Parameters	<u>Water pollution control law:</u> WWTP >2,000 p.e.: • 4 parameters : BOD5, suspended solids, faecal coliforms, helminth eggs • 17 physico-chemical parameters WWTP <2,000 p.e.: • 4 parameters: BOD5, suspended solids, faecal coliforms, helminth eggs <u>Code of Good Agriculture Practice:</u> does not include specific parameters.
Monitoring	<u>Water pollution control law:</u> Minimum required frequencies for the monitoring of parameters. Sampling and analysis are carried out by: • Urban Sewerage Boards, Water Development Department or Department of Environment for WWTPs > 2,000 p.e. • Water Development Department for WWTPs <2,000 p.e. <u>Code of Good Agriculture Practice:</u> monitoring is not specified.
Application controls	<u>Water pollution control law:</u> no additional measures specified. <u>Code of Good Agriculture Practice:</u> • All hydrant systems (valves, faucet, etc.) to be signalled in order to prevent any uncontrolled use and to warn people that the water is undrinkable (red paint) • No cross section with potable water pipes • Pipes for reclaimed water to be placed at least 1 m lower than the water supply pipes • Setback distance required between pipes of recycled water and drinking water supply • Irrigation of grass and green space with reclaimed water to be done at night when there is no one in the area • Irrigation to be ceased one week before collecting in order to avoid contact of reclaimed water with fruits or vegetables
Permitting system	In Cyprus, almost 100% of the treated urban effluents are reused. Conditions for the reuse of the wastewater are included in the Wastewater Discharge Permits. These permits are issued by the Minister of Agriculture Natural Resources and Environment for the Sewerage Boards and the Water Development Department, for agglomerations > 2000 p.e.

Cyprus

References

Panayi, A. (2013) Use of a Public Perceptions study to assist policy making for reclaimed water reuse. 13th International Conference in Environmental Science and Technology, Water Development Department, Ministry of Agriculture, Natural Resources and Environment Republic of Cyprus. Available at:
[http://www.moa.gov.cy/moa/wdd/wdd.nsf/All/AF481AE1CFFDF40DC2257BE5001C8D6B/\\$file/ATHENS_Presentation_Sep_2013.pdf](http://www.moa.gov.cy/moa/wdd/wdd.nsf/All/AF481AE1CFFDF40DC2257BE5001C8D6B/$file/ATHENS_Presentation_Sep_2013.pdf)

France	
Reference document	Ministerial Order August 2010 related to the use of water from treated urban sewage for crop or green spaces irrigation Available at: http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000022753522&dateTexte=&categorieLien=id
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Treated wastewater from urban WWTPs with a gross organic pollution greater than 1.2 kg of BOD5 per day.
Potential uses and restrictions	11 allowed uses: • Food crops intended for human consumption, consumed raw • Food crops intended for human consumption subject to thermal process • Grassland • Recreational areas (golf courses, forests open to public) • Flowers sold cut • Other flowers • Nursery and shrub • Fodder crops • Other cereal crops • Fruit production • Forest exploitation with limited public access Prohibitions: • Irrigation with raw sewage • Irrigation with treated wastewater from WWTPs connected to certain animal by-products processing installations • Irrigation with treated wastewater from WWTPs whose sewage sludge do not comply with limit values specified by the French legislation on agricultural use of sewage sludge • Irrigation with treated wastewater on soils that do not comply with limit values specified by the French legislation on agricultural use of sewage sludge • Irrigation with treated wastewater within the close protection perimeters of drinking water abstraction points (with some exceptions).
Approach	4 water quality levels are defined, each with specific numerical limit values for a range of parameters The required quality level is specified for each use category. The particularity of the French approach is that the monitoring programme to be put in place partly relies on the monitoring of sewage sludge quality and agricultural soils, in accordance with the French legislation on the agricultural use of sewage sludge. Sewage sludge quality is indeed considered to be a reliable indicator of the overall WWTP efficiency with regard to the removal of pathogens and other hazardous substances.
Parameters	• 6 parameters for the reclaimed water: suspended solids, chemical oxygen demand, faecal

France	
	coliforms, F-specific bacteriophages, spores of sulphate-reducing anaerobic bacteria, E. coli • Specific parameters for sewage sludge and agricultural soils, in accordance with the French legislation on sewage sludge spreading
Monitoring	Minimum required frequencies for the monitoring of the E. Coli parameter, for the different quality levels. The WWTP operator is in charge of implementing a monitoring programme (at the outlet of the WWTP) including: • Sampling and analysis of E. Coli according to a specific schedule • Annual monitoring of all 6 parameters • Monitoring of the quality of sewage sludge produced by the WWTP (at least 4 times/year) The WWTP operator shall communicate the monitoring results to the Préfet, the mayors concerned and the users of irrigated land. If one parameter exceeds the limit value, the WWTP operator shall inform the users of irrigated plots, the Préfet and the municipalities concerned. At least every 10 years, the user of irrigated land shall perform an analysis of soil samples targeting the trace elements covered by the French legislation on the agricultural use of sewage sludge. Results shall be communicated to the WWTP operator. Traceability measures: irrigated plot managers have to maintain a register with indications of crop location and type, volumes of reused water, the time during which crops are irrigated with reused water and the results of the monitoring programme (on reclaimed water, sludge and soils).
Application controls	• Several measures required to avoid cross contamination risks between the reclaimed water network and the drinking water network • Setback distances between areas irrigated with treated wastewater and specific activities • Maximum authorised land slope • Spray irrigation cannot be conducted if wind speed exceeds specified values
Permitting system	An authorisation shall be granted by the Préfet (local competent authority) before reusing treated wastewater. It can be submitted by the WWTP operator or the owner of irrigated land. The contents of the application file are specified by the regulation.

Greece	
Reference document	Joint Ministerial Decree 145116/11 Available at: http://www.ypeka.gr/LinkClick.aspx?fileticket=WhFRuaqvKXs%3D&tabid=251&language=el-GR
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Treated urban and industrial wastewater
Potential uses and restrictions	7 use categories: • Agricultural use: restricted irrigation • Agricultural use: unrestricted irrigation • Urban use (landscape irrigation and non-irrigation applications) • Groundwater recharge - infiltration - surface spreading (non-potable purposes) • Groundwater recharge - injection wells (non-potable purposes) • Industrial use (once-through, non-contact cooling water) • Industrial use (recirculating cooling water, boiler make up water, process water)
Approach	Minimum level of treatment required for each use category. Numerical limit values for a range of parameters, defined for each use category.
Parameters	• 4 bacteriological parameters • 19 chemical parameters • 14 other parameters for irrigation • 43 other parameters for toxic substances
Monitoring	Minimum required frequency for sampling and analysis.
Application controls	Not specified
Permitting system	Reusing treated wastewater requires a permit under this regulation.
References	Stathatou, P.M., Gad, F.K., Kampragou, E., Grigoropoulou, H. and Assimacopoulos, D. (undated) Treated wastewater reuse potential: Mitigating water scarcity problems in the Aegean Islands (http://environ.chemeng.ntua.gr/en/UserFiles/files/treated_wastewater_reuse_potential.pdf)

Italy	
Reference document	Decree of Environmental Ministry 185/2003 Available at: http://gazzette.comune.jesi.an.it/2003/169/2.htm
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Treated urban and industrial wastewater
Potential uses and restrictions	Quality requirements are defined for 3 use categories: • Agriculture • Non-potable urban uses • Industrial uses
Approach	Numerical limit values related to the bacteriological and physico-chemical water quality. Same values for the 3 use categories.
Parameters	55 parameters For parameters such as pH, ammonia nitrogen, specific electrical conductivity, aluminium, iron, manganese, chloride and sulphate concentrations, regional authorities may set limit values other than those mentioned in the Decree (after validation from the Ministry of Environment and the authorities in charge of the Protection of Natural Resources). For example: • In Emilia Romagna and Puglia regions: microbiological standards are similar to those of the California Title 22 guidelines. • In Sicily, microbiological standards are similar to those of the WHO guidelines.
Monitoring	The distribution network owner is responsible for the monitoring of chemical and microbiological parameters, environmental and agronomical impacts, and impacts on soil. He shall send monitoring results to the regional authorities every year. A Control & Monitoring Plan to be implemented by the WWTP operator is set out in the discharge permit; this plan shall be proposed by the WWTP manager and agreed by the competent authority.
Application controls	• The treated waste water distribution network shall be separated from the drinking water supply network and constructed so as to avoid cross contamination • Reclaimed water delivery points shall be marked and clearly distinguishable from those of water intended for human consumption.
Permitting system	Under this regulation, an authorisation is required for discharging treated wastewater intended for reuse.
References	Kamizoulis, G., Bahri, A., Brissaud, F. and Angelakis, A.N. (undated) Wastewater recycling and reuse practices in Mediterranean region Recommended Guidelines (http://www.a-angelakis.gr/files/pubrep/recycling_med.pdf)

Portugal	
Reference documents	- Portuguese Standard NP4434, 2006 - Technical guide No14 for water reuse, 2010 (http://www.ordembilogos.pt/DIV_02.2010/Guia_Reutilizacao_S.pdf). This guide aims at providing the public with a supporting tool for the implementation of reclaimed wastewater reuse projects. It covers a wider scope as the National Standard.
Legally-binding provisions	Provisions of the standard are used as a basis for the delivery of reuse permits. Hence, they become legally-binding once they are included in the reuse permits.
Origin of the wastewater (urban/industrial/unspecified)	Treated urban wastewater
Potential uses and restrictions	<u>Standard:</u> Potential uses are mainly agricultural and landscape irrigation uses. 4 use categories are defined depending on the risk of microbiological contamination after irrigation: - Vegetables to be eaten raw - Public parks and gardens, sport lawns, forest with easy public access - Vegetables to be cooked, forage crops, vineyards, orchards - Cereals (except rice), vegetables to be processed prior to consumption, crops for textile industry, crops for oil extraction, forest and lawns located in places with difficult or controlled public access Irrigation of vegetables whose edible parts may be in close contact with treated wastewater is forbidden. <u>Technical guide:</u> 17 potential uses grouped into 6 categories: - Agricultural and landscape irrigation: vegetables to be eaten raw, green areas with easy public access, vegetables consumed after processing, pastures, vineyards, orchards, crops and green areas with controlled access. - Industrial uses: unrestricted uses (cooling systems, heating boilers), restricted uses (textile, paper, processing and cleaning) - Groundwater recharge - Recreational uses - Environmental uses Non-potable urban uses: street cleaning, car washing, fighting fires, restricted uses
Approach	<u>Standard:</u> Numerical limit values for a range of parameters <u>Technical guide:</u> For each of the 17 potential uses, a numerical limit value for each parameter is recommended.
Parameters	<u>Standard:</u> 23 (?) physico-chemical parameters 2 bacteriological parameters: faecal coliforms and helminth eggs <u>Technical guide:</u> 13 parameters with specific limit values for each water use: DBO5, suspended solids, total dissolved solids, nitrogen, phosphorus, hardness, alkalinity, turbidity, iron, SiO2, faecal coliforms, helminth eggs, other chemical parameters (only defined for irrigation uses)

Portugal	
Monitoring	<u>Standard and Technical guide</u> : Minimum recommended frequencies for the monitoring of parameters
Application controls	<u>Standard</u>: Procedures concerning the irrigation installation and the irrigation site to minimise groundwater and surface water contamination risks, contact of people and animals with the irrigation water, transportation of droplets by wind, and inhalation of aerosols: • Guidance on signalling the irrigation layout of piping, • Time schedule of irrigation sessions • Protection equipment for irrigation operators • Restriction of animal access to irrigation field • Wind speed for spray irrigation • Field drainage and protection with a tree curtain <u>Technical guide</u>: no additional measures specified.
Permitting system	Reusing water requires a permit under the Decree Law No 236/98. Permits are issued by the Portuguese Environmental Agency (APA). The permit is based on the analysis of the reuse project, including the water quality control procedures, the water application protocol and the agreement of the Health Authorities in the case of (public) irrigation.
Comments	NP 4434 requires the same treated wastewater quality for irrigation uses as set by the Decree Law No 236/98 (which sets standards, criteria and quality objectives for different water uses). The quality levels correspond to those recommended by the FAO guidelines for wastewater treatment and use in agriculture (with minor exceptions).
References	Marecos do Monte, M.H.F. (2007) <i>Guidelines for Good Practice of water reuse for irrigation: Portuguese Standard NP 4434</i>. In: Wastewater Reuse-Risk Assessment, Decision-Making and Environmental Security (ed. M.K. Zaidi), pp. 253-265. Springer, Amsterdam. Available at: http://books.google.fr/books?id=c2bUyTkNq_QC&pg=PA256&lpg=PA256&dq=Portugal+water+reuse+standards&source=bl&ots=8_4w2tPbSE&sig=Xt91dE5_swUZnYTEmuLIBQ9olJQ&hl=fr&sa=X&ei=0uymUpSUNMOThgfozYGgDQ&ved=0CFkQ6AEwBA#v=onepage&q=NP&f=false Marecos do Monte, M.H.F. (2008) Sustainable water reuse in Portugal. WSEAS TRANSACTIONS on ENVIRONMENT and DEVELOPMENT. Issue 9, Vol. 4 (716-725) (http://www.wseas.us/e-library/transactions/environment/2008/27-579.pdf)

Spain	
Reference document	Royal Decree 1620/2007 Available at: http://www.boe.es/diario_boe/txt.php?id=BOE-A-2007-21092
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	'Treated wastewater' (origin is not specified)
Potential uses and restrictions	Quality requirements are defined for 24 use categories: • Urban: residential areas; services; • Agriculture: food crops intended for human consumption, consumed raw; food crops intended for human consumption, industrially processed; aquaculture; grassland; localised irrigation for woody cultures for which water can be in contact with fruits intended for human consumption; flowering plant irrigation without direct contact with water; industrial crops not intended for human consumption • Industry: water for industrial processes or cleaning (except for food industry); water for industrial process and cleaning for food industry; cooling towers and evaporative condensers; • Recreational area: golf courses; ponds; • Environmental: aquifer recharge by infiltration; aquifer recharge by injection; forests accessible to the public; wetlands. Water reuse is forbidden for several use categories: water intended for human consumption (except in catastrophe situation), use in hospitals, bathing water, fountain or ornamental products in public spaces, and all other uses presenting health risks.
Approach	14 water quality levels are defined, each with specific numerical limit values for a range of parameters. The required water quality level is specified for each use category.
Parameters	• 4 main parameters with numerical limit values for each use category: nematodes, E. coli, suspended solids, turbidity • 14 physico-chemical parameters specific to agricultural uses • 67 dangerous substances (same limit values for all use categories) • For some use categories (not all), the monitoring of other specific parameters is required: legionella, salmonella, taenia saginata, taenia solium, nitrogen
Monitoring	• Minimum monitoring frequency required for the various parameters • Reference methods and techniques for the analysis of measurements are recommended. The holder a water reuse authorisation is responsible for water quality and monitoring from the place reclaimed water enters the reuse distribution network to the point it is delivered. The user is responsible from the point of reclaimed water delivery until the place of use.
Application controls	Not specified

Spain	
Permitting system	The decree establishes the administrative regime to obtain a permit for water reuse. Usually, it is done through a modification of the waste water permit, by adding complementary quality requirements based on the intended use of the water. An application form for the granting of a water reuse permit is attached to the Royal Decree 1620/2007. Another possibility for obtaining a water reuse permit is through an administrative concession.
Comments	More comprehensive guidelines developed by certain regions (Andalucia, Balearic Island and Catalonia). One can apply for a water reuse permit even if the intended use is not mentioned in the decree, however the request will need to be justified.

Selection of widely-used standards at the international level

Australia	
Reference documents	Australian guidelines for water recycling: Managing health and environmental risks. - The 'Phase 1' document (2006) provides a generic framework for management of recycled water quality and use that applies to all combinations of recycled water and end uses. It also provides specific guidance on the use of treated sewage and greywater for purposes other than drinking and environmental flows. - A series of 'Phase 2' documents provides further guidance for some specific applications: Stormwater reuse (guidelines issued in 2008), Managed aquifer recharge (2009) and Recycled water for drinking (2009). Available at: http://www.recycledwater.com.au/index.php?id=16
Legally-binding provisions	No, but can be used as a basis for setting permit conditions
Origin of the wastewater (urban/industrial/unspecified)	Treated urban wastewater, stormwater and greywater
Potential uses and restrictions	7 use categories: - Agricultural uses - Fire control uses: controlling fires, testing and maintenance of fire control systems, training facilities for fire fighting - Managed aquifer recharge - Municipal uses: irrigation of public parks, gardens, roadsides, sporting facilities, road making and dust control, street cleaning - Residential and commercial property uses: toilet flushing, garden watering, car washing, water features and systems (ponds, fountains, cascades), utility washing (paths, vehicles, fences) - Industrial and commercial uses: cooling water, process water, wash-down water - Environmental uses: streams and creeks, rivers, lakes and dams

Australia

Approach

An important feature of these guidelines is that they recommend a risk management framework, rather than simply relying on post-treatment testing as the basis for managing recycled water schemes. The framework involves identifying and managing risks in a proactive way, rather than simply reacting when problems arise.

The guidelines provide a “fit for purpose” methodology for cost-effective treatment to be applied to a water source sufficient to meet the quality appropriate for the intended use. By matching a reuse application to a wastewater source and type of treatment, water supply costs can be controlled and the costs for improved wastewater treatment technologies delayed until they are balanced by the benefits.

The guidelines require to identify and assess the main health and environmental risks, and to implement preventive measures and monitoring procedures needed to reduce those risks to an acceptably low level.

The guidelines specify the log removals of enteric pathogens for different treatment processes as well as the required log reductions for water reuse categories.

In the guidelines on Managed aquifer recharge (2008), a health-based target derived from DALYs was introduced (Disability-Adjusted Life Year: one DALY can be thought as one lost year of ‘healthy’ life). This target is intended for potable schemes: controls implemented to limit negative health impacts can be measured as a reduction in DALYs.

The guidelines are intended to serve as a common basis for the establishment of state-level guidelines or regulations.

According to Fisher (2012)¹⁴⁹, following the Australian guidelines to set up a water reuse project can prove itself to be challenging: the vendor has to fully understand risk assessment, treatment technology, and has to have operational experience in order to efficiently conduct the risk assessment necessary for application of a permit.

Parameters

- 10 indicative parameters are mentioned: suspended solids, turbidity, biochemical oxygen demand, microbial quality, including faecal pathogens and indicators, chemical quality, including salinity — for example, total dissolved salts (TDS) or electrical conductivity (EC), sodium adsorption ratio (SAR), nutrients (macro and micro), heavy metals, and metalloids, pesticides and other organics, algal counts, organic matter, colour

These parameters are not associated with numerical limit values.

Key characteristics that should be considered for monitoring include:

- Microbial indicator organisms
- Salinity, sodicity, sodium, chloride, boron, chlorine disinfection residues, nitrogen and phosphorus
- Any health or environment-related characteristic that can be reasonably expected to exceed relevant guideline values, even if occasionally
- Any characteristic of relevance to end use or discharge of the recycled water which can be reasonably expected to exceed the guideline value, even if occasionally

¹⁴⁹ Colin Fisher (2012) Sewer Mining to Supplement Blackwater Flow in a Commercial High-rise (Case Study from the 2012 USEPA Guidelines for Water Reuse)

Australia

Monitoring

All sites that could be affected by the use or discharge of recycled water may need to be monitored. The monitoring process is to be defined on the basis of the risk assessment.

Different steps are recommended:

- Determine the characteristics to be monitored
- Determine the points at which monitoring will be undertaken
- Determine the frequency of monitoring
- Check documentation and reliability of data
- Check satisfaction of users of recycled water
- Conduct short term evaluation of results
- Implement corrective responses

Monitoring data should be reviewed over time and after specific events, such as heavy rainfall, which can lead to poor water quality in stormwater systems.

Application controls

The following types of measures are listed as a guidance:

- Operator, contractor and end user awareness and training: they need to be aware of the potential consequences of system failure and of how decisions can affect public and environmental health
- Community involvement and awareness
- Restricting uses of recycled water
- Controlling methods of application
- Setting withholding periods between application of recycled water and use of irrigated areas or harvesting of produce
- Controlling public access during application or use of recycled water
- Using signage, labelling and communication to minimise accidental exposure

The guidelines stress the importance of supporting these preventive measures by education of users and monitoring using surveillance and auditing.

The document provides estimates of microbial hazards reductions provided by measures implemented at the site of water reuse application. It is however pointed out that there is limited information on the effectiveness of these preventive measures and that further research is required on this aspect.

Permitting system

Not covered by these guidelines. Defined at the state level.

California	
Reference document	Regulation related to Recycled Water, Title 22 of the Code of regulations, Title 22, Division 4, Chapter 3, section 60301 et seq (2009, updated in 2011) Available at: 2009 version: http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWregulations-01-2009.pdf (2009 version) and http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWstatutes2011-01-01.pdf (2011 amendments)
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Municipal wastewater ('Recycled water from sources that contain domestic waste, in whole or in part').
Potential uses and restrictions	47 potential uses grouped into 4 use categories: • Irrigation • Impoundments • Cooling • Other purposes: flushing toilets and urinals, priming drain traps, industrial process water that may come into contact with workers, fire-fighting, decorative fountains, commercial laundries, consolidation of backfill around potable water pipelines, artificial snow for commercial outdoor use, commercial car washes, etc.
Approach	Title 22 establishes uniform state-wide recycling criteria for the various uses of recycled water to assure protection of public health where recycled water use is involved. These regulatory criteria include specified approved uses of recycled water, numerical limitations and requirements, treatment method requirements and performance standards. For each potential use, a specific wastewater treatment technique is required. California has a system for approving and certifying treatment technologies under Title 22. In addition, for certain use categories, water quality criteria (numerical limit values for the total coliform content parameter) are defined and are legally-binding.
Parameters	• Only 1 parameter is specified in Chapter 3 of Title 22: total coliform content. • California however regulates various parameters for water and wastewater treatment in general, many of which may also apply to reuse. Quality parameters can also be built into definitions of treatment levels for water and wastewater, which may be contained in other regulations. Besides, many parameters may be contained in the permissions granted to individual schemes.
Monitoring	Minimum required frequency for sampling and analysis. The producer/supplier of the recycled water shall conduct the sampling. All monitoring results, operational problems, plant and equipment breakdowns, diversions to emergency storage or disposal, and all corrective or preventive actions shall be recorded (monthly summary shall be filed with the regulatory agency).

California

Application controls

- Setback distances between area of use or impoundment of recycled water and domestic water supply wells (setback distances vary depending on the treatment that has been applied to the wastewater)
- Runoff shall not enter dwellings, designated outdoor eating areas or food handling facilities and be confined to the recycled water use area
- Drinking water fountains shall be protected against contact with recycled water contamination
- Setback distance between spray irrigation of any recycled water and a residence or a place with public exposure similar to that of a park, playground or school yard
- Signalling of areas that are accessible to the public and where recycled water is used
- Physical connections between any recycled water system and any separate system conveying potable water are forbidden
- In publicly accessible areas: no hose bibs, only quick couplers.
- Preventive maintenance program to ensure that all equipment is kept in good operating condition
- Alarm devices required to provide warning in the case of loss of power from the normal power supply or in the case of treatment process failure

Permitting system

The process is defined by California Code of Water:

All persons who recycle or propose to recycle water, and who use or propose to use recycled water, must file a report with the appropriate regional water board. This report shall be prepared by a qualified engineer registered in California and experienced in the field of wastewater treatment. The report shall indicate the means for compliance with the Californian regulations and any other features specified by the regional water board. If a regional water board determines that it is necessary to protect public health, safety, or welfare, it may prescribe water recycling requirements where recycled water is used or proposed to be used. The regional water boards must consult with and consider recommendations of the Department of Health Services (DHS) when issuing waste discharge/water recycling requirements; 'Title 22' criteria are used as a basis by the DHS to provide these recommendations.

Comments

California can be seen as a pioneer in the regulation of water reuse, as the first water reuse guidelines were published in 1918.

Mediterranean countries	
Reference document	United Nations Environment Programme, Guidelines for municipal water reuse in the Mediterranean region, 2005 Available at: http://195.97.36.231/dbases/Acrobatfiles/05WG270_Inf19_eng.pdf
Legally-binding provisions	No
Origin of the wastewater (urban/industrial/unspecified)	Unspecified
Potential uses and restrictions	11 potential uses grouped into 4 categories: • Urban and residential uses, landscape and recreational impoundments • Unrestricted irrigation, landscape impoundments (contact with water not allowed) and industrial uses • Restricted agricultural irrigation • Irrigation with reclaimed water application systems or methods (drip, subsurface,...) providing a high degree of protection against contamination and using water more efficiently
Approach	Recommended water quality criteria (numerical limit values) and wastewater treatment expected to meet the criteria are defined for each water reuse category.
Parameters	• 2 microbiological: intestinal nematode, faecal coliforms or E. coli • 1 physico-chemical: suspended solids
Monitoring	• Water quality monitoring recommendations are provided for each water reuse category (sampling frequency, sampling points, etc.) When a potable unconfined aquifer lays below agricultural sites irrigated with reclaimed water, monitoring should be based on a set of wells and piezometers (depending on reclaimed water quality and hydrogeological context). Soil quality monitoring is also recommended (monitoring the accumulation of pollutants threatening the agronomic quality of irrigated soils).
Application controls	• Treatment facility design shall include alarms, alternative power supply, backup or multiple unit processes • In the case of treatment process failure, emergency storage or disposal provisions of untreated or partially treated wastewater should be available • Recommended reclaimed water storage capacity is the one week highest demand in a year • Cross-connection with protective devices such as double check valve assembly when dual-distribution systems are present • Colour-coded water pipes and outlets to identify that reclaimed water is being used • Signposting, warning notices, symbols, should be posted at water valves • Setback distances between facilities using reclaimed water and areas where the public or potable water supply may be exposed (distance depends on the quality of reclaimed water, the method of irrigation, the radius of wetted area, climatology and hydro-geological aspects of the site) • Restrictions on the types of crops • Agricultural field workers should wear protective clothing

Permitting system	Not covered by these guidelines
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USA	
Reference document	USEPA Guidelines for water reuse 2012 Available at: http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf A first version of these guidelines was issued in 1980, and was updated in 1992, 2004, and 2012.
Legally-binding provisions	No
Origin of the wastewater (urban/industrial/unspecified)	Treated municipal wastewater
Potential uses and restrictions	13 water reuse categories: • Urban reuse: unrestricted, restricted • Agricultural reuse: food crops, processed food crops and non-food crops • Impoundments: unrestricted, restricted • Environmental reuse • Industrial reuse : once-through cooling; recirculating cooling towers • Groundwater recharge - non potable reuse • Potable reuse: indirect reuse (groundwater recharge by spreading into potable aquifer, by injection into potable aquifer, augmentation of surface water supply reservoirs), direct reuse
Approach	For each water reuse category, guidance is provided on: • Level of treatment needed • Parameters and numerical limit values to reach a specified water quality • Reclaimed water monitoring • Setback distances These guidelines are not intended to be used as definitive water reclamation and reuse criteria. They are intended to provide reasonable guidance for water reuse opportunities, particularly in states that have not developed their own criteria or guidelines. They can be used as a basis for the development of state regulations. Nowadays, 22 States have adopted regulations (including for example California, Florida, Arizona and Texas) and 11 States have guidelines or design standards with water reuse as the primary intent. Additionally, eight states have regulations and four have guidelines that implicate water reuse primarily from a disposal perspective.
Parameters	• 6 parameters (pH, BOD, turbidity, faecal coliform, chlorine residues, total suspended solids) • 19 additional chemical parameters and maximum concentration for irrigation purposes • 2 additional parameters for indirect potable reuses: Giardia, Cryptosporidium

USA

Monitoring	For each water reuse category, recommended frequencies for parameters monitoring are indicated. Maintenance of periodical (e.g. annual) reuse inventory is recommended as an essential item in tracking success of a state's water reuse program. For instance, in Florida, reclaimed water production plants are required by their permits to submit an annual reuse report every year. The data is not only used in the state's annual reuse inventory report and reuse statistics but is also shared with the Water Reuse Association's National Reuse Database.
Application controls	• Setback distances are indicated for the different water reuse categories • Human contact with reclaimed water should be minimized • Milking animal should be prohibited from grazing for 15 days after irrigation ceases or a higher level of disinfection should be provided in case this waiting period would not be adhered to • For impoundments reuse, nutrient removal may be necessary in order to avoid algae growth • Dechlorination may be necessary for some water reuse categories in order to protect aquatic species of flora and fauna • For environmental reuse, possible effects on groundwater should be evaluated and reclaimed water temperature observed • Windblown sprays should not reach areas accessible to workers or the public • For groundwater recharge (non-potable reuse), the facility should be designed in order to ensure that no reclaimed water reaches potable water supply aquifers • For indirect potable reuse, depth to groundwater should be at least 6 feet (2 m) at the maximum groundwater mounding point; reclaimed water should be retained underground for at least 2 months prior to withdrawal; monitoring wells are necessary to detect the influence of the recharge operation on groundwater
Permitting system	Not covered by these guidelines. Defined at the state level.

WHO	
Reference document	WHO Guidelines for the safe use of wastewater, excreta and greywater, 2006 Available at: http://www.who.int/water sanitation health/wastewater/gsuww/en/
Legally-binding provisions	Yes
Origin of the wastewater (urban/industrial/unspecified)	Wastewater consisting of domestic sewage that does not contain industrial effluents at levels that could pose threats to the functioning of the sewerage system, treatment plant, public health or the environment
Potential uses and restrictions	• Agriculture (Volume II of the guidelines) • Aquaculture (Volume III of the guidelines)
Approach	Risk management approach, including the following steps: • Identifying hazards • Generating evidence for health risks and the effectiveness of possible health protection measures to manage them • Establishing health-based targets to manage health risks: measurement of the gap between current health status and an ideal health situation using DALY per year and per person units (Disability-Adjusted Life Year: one DALY can be thought as one lost year of 'healthy' life). The guidelines provide health based targets for treated water use in agriculture for 6 exposure scenarios: unrestricted irrigation (lettuce or onion); restricted irrigation (highly mechanized or labour intensive); localized (drip) irrigation (high growing crops or low-growing crops). • Implementing health protection measures to achieve the health-based targets • System assessment and monitoring. Volumes II and III provide lists of selected wastewater treatment processes and the corresponding log unit pathogen removals. Volume II also lists some advantages and disadvantages of each selected treatment process.
Parameters	Volumes II and III provide a list of validation, operational monitoring and verification monitoring parameters: • 19 'validation' parameters • 24 'operational monitoring' parameters including e.g.: flow rates, BOD, algal concentration, dissolved oxygen, turbidity, pH, organic carbon, particle counts, membrane integrity (pressure testing), chlorine residual, types of crops, application timing and time to harvest, Etc. • 13 'verification monitoring' parameters including e.g.: E. coli, helminth eggs, locally relevant toxic chemicals, etc. Volume II also provides a list of 8 environmental parameters and provides details of their potential effects on soils, crops and livestock for a given concentration of these parameters in the irrigation water, as well as their relative impact on groundwater and surface water bodies: pathogens, salts, metals, toxic organic compounds, nutrients, organic matter, total suspended solids, pH

WHO	
Monitoring	3 types of monitoring: • Validation is the initial testing to prove that a system as a whole and its components are capable of meeting the performance targets • Operational monitoring is the routine monitoring of parameters that can be measured rapidly to inform management decision and prevent hazardous conditions from arising • Verification monitoring is regularly carried out to demonstrate that the system is working as intended.
Application controls	• Recommendations on how to choose the treated wastewater application method, in order to reduce health risks for farm workers, consumers and nearby communities. • Recommended measures to reduce pathogens: vigorous washing of rough-surfaced salad crops and vegetables eaten uncooked in tap water; peeling fruits; cooking vegetables • Use of protective clothing • Suggestions on measures to control some environmental impacts are presented by polluting agent or by type of environmental issue • Health protection measures against trematodes for wastewater reuse in aquaculture • Health protection measures depending on the waste-fed aquacultural system chosen
Permitting system	Not covered by these guidelines.
Comments	Microbial quality targets (numerical limit values) are provided for waste-fed aquaculture. Verification monitoring of chemical concentrations in waste-fed aquacultural products should be conducted at six months intervals by local food authorities. Contaminants that are at elevated concentrations can be singled out for more routine monitoring as necessary. Indicative limit values for chemical concentrations in fish and vegetables are also provided (arsenic, cadmium, lead, methylmercury, dioxins, DDT, TDE, PCBs)

ISO (under development)	
Reference document	Documents are under development First drafts of the ISO standard on ISO/PC 253 - Treated wastewater re-use for irrigation are available at: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=616869
Legally-binding provisions	No
Preliminary information	ISO standards on the reuse of treated wastewater are under development, following a request from Japan, China and Israel (ISO/TC 282 committee on Water re-use¹⁵⁰). The ongoing work concerns the standardisation of water re-use of any kind and for any purpose. It covers both centralised and decentralised or on-site water re-uses, direct and indirect ones as well as intentional and unintentional ones. The standards will include technical, economic, environmental and societal aspects of water re-use; however, they will exclude the definition of allowable water quality limits in water re-use, considering that such limits should be determined by the governments, WHO and other relevant competent organizations. The draft strategic business plan¹⁵¹ (Dec 2013) specifies the main objectives and priorities in the work of the committee. ISO/TC 282 standards deal with: • The definition of a terminology common to the different stakeholders. • Specification of the elements to be considered for planning, designing, operation, monitoring and maintenance of water re-use including for various fields including irrigation, urban, environmental and industrial uses. • Methods and indicators for risk and performance evaluation of water re-use system. Japan and China hold the secretariat and of the 19 participating countries, 7 are from the EU. Further details can be found in the ISO Technical Management Board Resolution 19/2013¹⁵². With regard to irrigation uses, work is underway to develop the ISO 16075 series 'Guidelines for Treated Wastewater Use for Irrigation Projects'¹⁵³, with a targeted publication date in 2015. These guidelines aim to prevent any adverse impacts on public health, the environment, soils and crops, as a result of treated wastewater irrigation. The following first draft documents have been developed to date: • Part 1: The Basis of a Reuse Project for Irrigation – Includes in particular guidelines on maximum recommended levels of nutrients and salts in reclaimed water and on treatment levels to abate P, BOD, COD and heavy metals • Part 2: Development of the project – Includes in particular guidelines on limit values associated with different water quality levels, quality levels for different use types, setback distances, etc. • Part 3: Components of a reuse project for irrigation – Includes, in particular design specifications for the treatment, storage, distribution and irrigation infrastructure. • Part 4: Monitoring.

¹⁵⁰ http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=4856734

¹⁵¹ http://www.aspe.org/sites/default/files/webfm/pdfs/N19_Draft_Strategic_Business_Plan_TC282_.pdf

¹⁵² http://www.iisc.go.jp/international/nwip/tsp236_Water%20re-use.pdf

¹⁵³ http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=616869

ANNEX C: Non-EU countries – Examples of policy measures related to water reuse and examples of reuse schemes

Geographical scope	Key policy measures
Australia	<u>Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (AGWR)</u>¹⁵⁴: See the standards comparison in Annex B. <u>Economic incentives – Pricing of treated wastewater</u> (WSAA, 2005) Some schemes with the aim to avoid or reduce effluent discharge into sensitive aquatic environments do not charge at all treated wastewater if for reuse purposes. <u>Targets at national, state and city-level</u> Government commitments at all levels towards water supply source diversification, as well as the persistence of economic and regulatory barriers seen as inhibiting the unassisted growth of water recycling activities, have seen most jurisdictions commit to wastewater recycling targets over various time horizons (MJA, 2012). Details of state-level targets can be found in (MJA, 2012). Furthermore, in 2007, the Australian Government itself committed to a national target of recycling 30% of wastewater by 2015. According to MJA (2012), 16.8% were recycled in 2009/10 and the predicted recycling rate for 2015 varies between 18.7% to 20.3%. In addition, many major cities and several states have set targets to achieve specific percentages of wastewater recycling (expressed in % of wastewater/stormwater to be recycled, with stormwater only representing a small proportion), e.g.: - Sydney: 10% recycling by 2020¹⁵⁵ - Brisbane: 20% recycling by 2010¹⁵⁵ - Perth: 30% by 2030; 60% by 2060 (MJA, 2012) - South Australia: 35% by 2015 (urban) and 29% by 2015 (country) (MJA, 2012) - Melbourne: 20% by 2010 (officially achieved, no new target) (MJA, 2012).
Israel	<u>Ministry of Health Regulations (2005)</u> (from Alcalde-Sanz et al., 2014) Quality standards for unrestricted agricultural irrigation. Based on the Californian Title 22 Regulations (very restrictive). Methods of treatment and setback distances are included. <u>Subsidies for treated wastewater</u> (from Fine et al., 2006) Water reuse for agriculture is highly subsidised. The Israeli State fully pays for the conveyance and storage of water and also takes over the cost for upgrading wastewater to a high quality level. The users (farmers) are only charged the cost for 'low level treatment' suitable for restricted irrigation, 0.098 EUR/m³. This subsidisation is less costly than treating wastewater to a quality suitable for discharge into surface waters.

¹⁵⁴ Phase 1 (2006): <http://www.environment.gov.au/water/publications/quality/pubs/water-recycling-guidelines-health-environmental-21.pdf>

Phase 2 (2008): <http://www.environment.gov.au/water/publications/quality/pubs/water-recycling-guidelines-augmentation-drinking-22.pdf>

¹⁵⁵ Source: Recycled water in Australia website (<http://www.recycledwater.com.au/index.php?id=62>).

Geographical scope	Key policy measures
Jordan	<u>National Water Strategy 'Water for Life' 2008-2022¹⁵⁶</u> This strategy set Goals for Wastewater by 2022 and details the approach to reach these goals. In particular, the Jordanian Government intends to increase reuse of treated domestic wastewater in agriculture to 220 Mm³ until 2022, which then would constitute 13% of the available water resources. <u>Reclaimed Domestic Wastewater Standard No 893/2006</u>, including Reclaimed water for reuse. These standards establish a variable standard for wastewater quality for 7 categories of discharge or direct reuse. They include the following categories of wastewater reuse (ACWUA, 2011): • Recycling of water for irrigation of vegetables that are normally cooked • Recycling of water used for tree crops, forestry and industrial processes • Discharges to receiving water such as valleys and catchments areas • Use in artificial recharge to aquifers not used for drinking purposes • Discharge to public parks or recreational areas • Use in irrigation of animal fodder • Use of reclaimed water for cut flowers <u>Industrial Wastewater Standard Specification No 202/2007</u> This standard defines the quality for final discharge of industrial wastewater to water bodies or irrigation. Standard 202 incorporated Standard no.893/2006 concerning the reuse of industrial wastewater for irrigation or for industrial uses (ACWUA, 2011).
Singapore	<u>Awareness raising measures¹⁵⁷</u> NEWater Study initiated in 1998 by the government. Ambitious project to increase water reuse for indirect potable uses and direct non-potable uses. For non-potable uses, the target for 2011 was to cover to 30% of Singapore's water needs with the so-called 'NEWater'. This project was accompanied by an impressive public awareness program to build a national commitment to water reuse. A Visitor's Centre was built to convey information on the project.
USA	<u>2012 Guidelines for Water Reuse (USEPA)¹⁵⁸</u>. See the standards comparison in Annex B. <u>Information dissemination</u> The National Water Reuse Database (NWRD) (NWRD Website¹⁵⁹; WateReuse Foundation, 2008) provides utility/facility general information and annual data on the flow, treatment, and end use of recycled water from the states reusing the most water: California, Florida and Texas. It aims to encourage, improve and disseminate information regarding the practice of water reuse, in order to advance the practice and implementation of water reuse at the local, regional, state and national level. It is maintained by the WateReuse Association and was developed through a WateReuse Research Foundation project.

¹⁵⁶ Jordan's Water strategy 2008-2022, available from

http://www.joriew.eu/uploads/private/joriew_org_jordan_national_water_strategy.pdf

¹⁵⁷ NEWater: Singapore's Experience in Water Reuse (http://www.watereuse.org/files/images/Harry_Seah.pdf)

¹⁵⁸ USEPA (2012) Guidelines for Water Reuse (factsheet available at:

<http://www.epa.gov/region9/water/recycling/pdf/water-reuse-guidelines-fact-sheet-2012.pdf>)

¹⁵⁹ <http://www.watereuse.org/info/nwrld>

Geographical scope	Key policy measures
California, USA	<u>Recycled Water Policy (as modified by State Water Board Resolution 2013-0003)</u> This policy includes specific targets for water recycling and water conservation: • Increase the use of recycled water over 2002 levels by at least one million acre-feet per year (afy) (~ 1,233 Mm³/y) by 2020 and by at least two million afy (~2,467 Mm³/y) by 2030. • Increase the amount of water conserved in urban and industrial uses by comparison to 2007 by at least 20 percent by 2020. • Included in these goals is the substitution of as much recycled water for potable water as possible by 2030. • Increase the use of stormwater over use in 2007 by at least 500,000 afy by 2020 and by at least one million afy by 2030. In addition, the State Water Code clearly states that <i>'It is the intention of the Legislature that the State undertakes all possible steps to encourage development of water recycling facilities so that recycled water may be made available to help meet the growing water requirements of the State'</i>. <u>California water recycling criteria in Title 22 of the California Code of Regulations¹⁶⁰</u> See the standards comparison in Annex B. <u>Awareness raising measures</u> In the city of San Diego, California, intense public opposition to water reuse changed over a period of many years, largely because of public outreach and stakeholder involvement, in addition to the economic driver of local water scarcity (USEPA, 2012).

Examples of water reuse schemes in non-EU countries

Israel

Reuse for irrigation purposes in the Be'er Sheva area (WaterWorld, 2012)

A farming community near Be'er Sheva pooled resources to construct a water reuse system adjacent to a WWTP. A total of 90% of the produced effluent will be piped for agricultural irrigation and the remaining 10% used for irrigation of municipal parks.

The "Third Line to the Negev" enterprise (Mekorot, 2006)

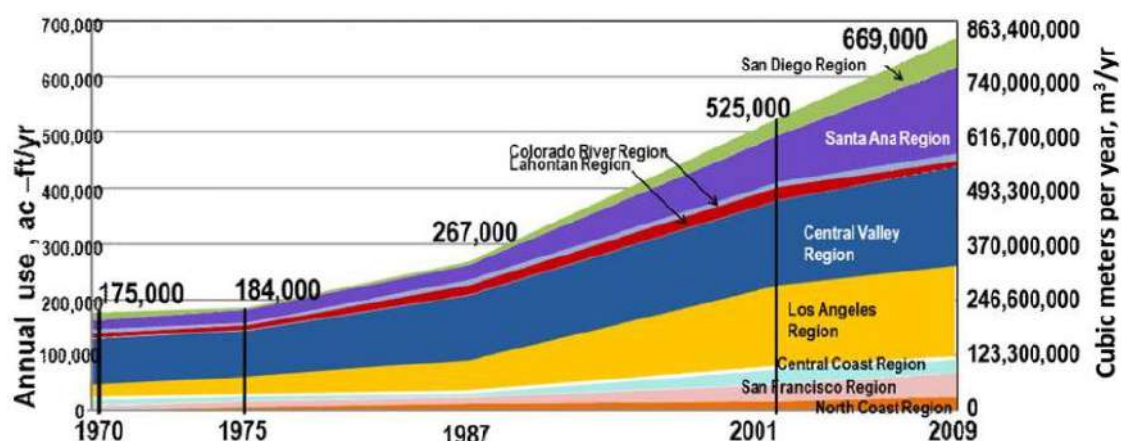
In Israel, the national water company Mekorot has implemented effluent reclamation schemes throughout the country: over 50% of the reclaimed effluent, representing 206 Mm³/yr from 9 reclamation plants, is used for different purposes. In particular, effluents from the Shafdan reclamation plant (145 Mm³/yr) are used for agriculture in the Negev, the reclaimed water being suitable for unlimited irrigation. This is achieved thanks to a combined system of pipes, reservoirs and pumping stations: three pipelines constitute the system, two of them supplying drinking water to the Negev and the third one providing reclaimed water for irrigation. The reservoirs are used to collect the stored reclaimed water during the winter and increase the quantity of water supplied for irrigation during the summer months.

USA – California

In California, as a result of strong policy incentives, water recycling has been growing steadily since the 1970s, as shown the figure below. In 2009, a total of 825 Mm³/y (669,000 ac-ft/yr) of recycled water was used.

¹⁶⁰ California Department of Public Health, Regulations related to Recycled Water, January 2009, available from <http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWregulations-01-2009.pdf>

Figure 14: Municipal recycled water use in California, 1970-2009.



Source: California Department of Water Resources (quoted in Lazarova V et al., 2013).

The Orange County's Groundwater Replenishment System (California)¹⁶¹

This project is the world's largest wastewater purification system for indirect potable reuse. The Groundwater Replenishment System (GWRS) takes highly treated wastewater that would have previously been discharged into the Pacific Ocean and purifies it using a three-step advanced treatment process. Operational since January 2008, this water purification project can produce up to 265,000 m³ of high-quality water every day, which is enough water to meet the needs of nearly 600,000 residents in north and central Orange County, California.

Non-potable water reuse in the San Francisco Bay area (California) (CCCSD, 2009; Hermanowicz et al., 2001)

In the Central Contra Costa Sanitary District (CCCSD), the effluent from a wastewater treatment plant serving 460,000 inhabitants is reused for a range of non-potable applications.

The recycled water is distributed in a separate system of pipe work to distinguish them from the potable distribution network, and is predominantly used for irrigation of golf courses, parks, campuses as well as for industrial purposes (concrete recycling). The long-term plan is to recycle 2,000,000 m³/year in this area.

In 2005, the system began providing recycled water to a new animal shelter, the first dual-plumbed facility in the area, where recycled water is used inside and outside the building. Moreover, although the urban reuse scheme was supposed to begin in 2001, it was delayed for 10 years because the facilities failed to meet ammonia requirements.

The Water Pomona Water Reclamation Plant (WRP), Los Angeles County (California)¹⁶²

The Pomona water reclamation plant provides primary, secondary and tertiary treatment of wastewater at 49 million litres/day. The plant serves a population of approximately 130,000 people. Approximately 30 million litres/day of the purified water is reused at over 90 different reuse sites. Reuse includes: landscape irrigation of parks, schools, golf courses, greenbelts, etc.; irrigation and dust control at the Spadra Landfill; and industrial use by local manufacturers.

¹⁶¹ www.asce.org/Sustainability/

Sustainability-Case-Studies/Orange-County,-CA,-Groundwater-Replenishment-System/

¹⁶² From the LA County Sanitation District (LACD) website:

http://www.lacsd.org/wastewater/wwfacilities/joint_outfall_system_wrp/pomona.asp

The remainder of the purified water is put back into the San Jose Creek channel where it makes its way to the unlined portion of the San Gabriel River. Therefore, nearly 100% of the water is reused since most of the river water recharges into the ground water.

Australia

On average, approximately 15% of the total output from sewage treatment plants was recycled in 2009. There are significant differences in reuse between states, with South Australia recycling greater than 20% of its wastewater and Australian Capital Territory and Northern Territory recycling less than 10%. Many major cities have set targets to achieve specific percentages of wastewater recycling.

The Western Corridor Recycled Water Project, Queensland (Traves et al., 2008)

The Queensland Government is constructing the Western Corridor Recycled Water Project which will supply up to 182 million litres/day of purified recycled water for industrial and potable purposes, based on the collection, treatment and delivery of wastewater from treatment plants.

Reuse of municipal wastewater for irrigation purposes in Gerringong and Gerroa, New South Wales (Tare, 2011 ;Veolia factsheets)

The Gerringong Gerroa sewerage scheme was implemented in 2001 and consisted of the construction of a state of the art WWTP in the Gerringong Gerroa region which became operational in 2002. The effluent recycling system is designed to reuse up to 80% of treated effluent. The treated effluent is stored in a 50,000 m³ storage dam before being pumped to a local dairy farm for pasture irrigation. When irrigation is not possible and the storage reservoir is full, high quality effluent is discharged to the local receiving waters.

Tunisia

Planned reuse has been developed since the 1960s. Wastewater reuse has become a priority in the national water resource strategy. In 2001, there were already more than 44 WWTPs, with a total design capacity of over 130 Mm³/year, producing secondary treated water, of which about 30% was recycled, most of it being used to irrigate some 6,500 ha of farmland (Lazarova et al., 2001).

Water recycling project for irrigation¹⁶³

In 2012, the African Development Bank launched a EUR 33m project for the recycling of treated wastewater. The objective is to achieve a 50% recycling rate of treated wastewater by 2016 (against 30% at present). This should enable the irrigation of 8,500 ha of agricultural land and urban green spaces.

Singapore

The NEWater reuse programme (PUB, 2011)

¹⁶³ <http://www.afdb.org/fr/news-and-events/article/afdb-loans-eur32-5m-to-tunisia-to-boost-flow-of-irrigation-water-to-countrys-farms-8881/>
<http://www.afdb.org/fr/news-and-events/article/afdb-launches-eur-33-million-waste-water-treatment-project-in-tunisia-9071/>

The NEWater Study was initiated in 1998 by the government, as an ambitious project to increase water reuse for indirect potable uses and direct non-potable uses. Like the San Francisco Bay Area scheme in California, this system took many years to be set up, with the original concept being laid out in 1973 and the first treatment plants being opened in 2003. The recycled water, called 'NEWater', is predominantly used by industry, with demand growing from 6,600,000 m³/year in 2003 to around 100,000,000 m³/year in 2011. This volume meets 30% of the needs of Singapore, and requires three treatment plants. This reuse scheme involves a small proportion of potable reuse with the 'NEWater' being mixed with water stored in surface reservoirs. This project was accompanied by an impressive public awareness program to build a national commitment to water reuse. A Visitor's Centre was built to convey information on the project. The creation of the terminology 'NEWater' is part of the strategy developed to improve consumer acceptance and engagement.

South Africa

The Durban Water Recycling Project (Tare, 2011; Veolia factsheets)

This project is a tri-sector partnership (public-private-NGOs). Effluent from the Southern Wastewater Treatment Works is treated to an acceptable standard for industrial use. The project includes treating primary sewage and re-purifying the 47,500 m³/day reclaimed water. By using recycled water, which is 25% less expensive than potable water, industry realises more than 50% savings (for example, Mondi Paper Mill saves up an amount equivalent to 3.5 M EUR/year). Therefore, more drinking water is now available for the local disadvantaged communities. This project allowed Durban Metro to install and operate a new affordable distribution network for the townships, while offering the industry cheap and high quality water.

ANNEX D: Overview of relevant EU legislation

Water-related legislation

Drinking Water Directive (80/778/EC revised with 98/83/EC)¹⁶⁴

The Directive contains provisions that are relevant to the indirect reuse of treated wastewater for drinking water production. The Directive does not include specific restrictions with regards to treated wastewater reuse. The general obligations require that Member States take the measures necessary to ensure that water intended for human consumption is wholesome and clean, which is defined through minimum requirements including microbiological and chemical parameters (article 4; Annex I).

The Directive is currently under review.

Bathing Water Directive (2006/7/EC)¹⁶⁵

The Directive contains provisions that are relevant to the reuse of treated wastewater for recreational purposes. The Directive concerns the management of bathing water quality and does not include restrictions regarding treated wastewater reuse. Member States are requested to take the measures to ensure that all bathing waters are at least 'sufficient' (article 5). The bathing water quality assessment is based on biological parameters (Annex I of the Bathing Water Directive).

Groundwater Directive (GWD) (2006/118/EC)¹⁶⁶

The GWD, together with the WFD, contains provisions that are relevant to the reuse of treated wastewater for aquifer recharge. '*Artificial recharge of aquifers*' is mentioned in article 11.3 (f) of the WFD and article 6.3(d) of the GWD. However, in these two Directives, aquifer recharge is not defined precisely. Only the source of water is specified: '*the water used may be derived from any surface water or groundwater, provided that the use of the source does not compromise the achievement of the environmental objectives established for the source or the recharged or augmented body of groundwater.*'

The exact references to aquifer recharge in the WFD and GWD are the following:

- Artificial recharge of aquifer is mentioned in the WFD (Annex VI, part B (xiv)) as a possible supplementary measure to be adopted as part of the Programmes of Measures required under article 11(4). However, '**prior authorisation of artificial recharge**' is required, as well as '**periodical controls**' as specified in Article 11.3 (f) of the WFD.

¹⁶⁴ Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

¹⁶⁵ Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

¹⁶⁶ Directive 2006/118/EC on the protection of groundwater against pollution and deterioration

- The GWD mentions in its article 6 that exemptions concerning pollutants' input limitation measures are possible in the case of aquifer recharge, provided that '*efficient and appropriate monitoring*' is being carried out and '*without prejudice to any more stringent requirements*'. Such more requirements could for instance apply where the recharge might affect a Natura 2000 area or drinking water production.

As a conclusion, artificial recharge with treated wastewater is not explicitly excluded by the WFD or by the GWD; therefore aquifer recharge may be implemented as far as Member States issue permits and undertake appropriate monitoring. Measures to prevent or limit inputs of pollutants into groundwater are defined by Article 6 of the GWD. A number of detailed recommendations on 'direct and indirect inputs' in the context of the GWD are available in the **guidance document n°17**.

In addition to the chemical status objectives of the WFD, groundwater has also to be protected as a drinking water resource under Articles 6 and 7 of the WFD. In this context, groundwater bodies used for the abstraction of water intended for human consumption have to be delineated as protected areas (Article 6 WFD) and protected in such a way as to ensure compliance with Article 7 of the WFD. This stipulates, in particular, that the necessary protection for bodies of water has to be ensured with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. Hence, the resulting water has to meet the requirements of the DWD, which means that quality controls related to water reuse operations need to consider microbiological contamination risks and not only pollution by chemical substances. Details are available in the Guidance document CIS n°162 on 'Groundwater in Drinking Water Protected Areas'.

At the time of writing this report, Annexes I and II of the GWD were under review. These annexes contain environmental quality standards for pollutants, a minimum list of pollutants and indicators for which Member States should consider establishing threshold values, guidelines for the establishment of threshold values and information to be provided by Member States on those pollutants and indicators.

Environmental Quality Standards Directive (Directive 2008/105/EC, as amended by Directive 2013/39/UE) (EQSD)¹⁶⁷

This Directive, also known as the **Priority Substances Directive**, sets environmental quality standards (EQS) for a number of substances presenting a significant risk to or via the aquatic environment at EU level in surface waters (river, lake, transitional and coastal). These substances are classified as 'priority' or 'priority hazardous' substances, the latter being a subset of particular concern.

In 2013, 12 new substances were added to the EU priority list of pollutants that are known to pose a risk to surface waters (the list now includes 45 substances). In addition, three pharmaceuticals have been included on a "watch list" of emerging pollutants that could one day be added to the priority list.

According to Annex V, point 1.4.3 of the WFD and Article 1 of the EQSD, good chemical status is reached for a water body when it complies with the EQS for all the priority substances and other pollutants listed in Annex I of the EQSD.

¹⁶⁷ Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy

The provisions of this Directive are particularly relevant to the reuse of treated water for environmental purposes such as aquatic ecosystem restoration or the creation of new aquatic environments. In such cases, quality requirements for the reclaimed water will be dictated by the need for the receiving waters to comply with the EQS.

Nitrate Directive (91/676/EEC)¹⁶⁸

Treated wastewater reuse in agriculture can support the achievement of the Nitrates Directive's objectives, but requires adequate monitoring of its nitrogen content. The Directive aims to protect water quality by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. It contains provisions for the designation of vulnerable zones and for action programmes for such zones (including global nitrogen balance to ensure equilibrium between nitrogen application with fertilisers and crop uptake in fertilisation practices) (Annex III, 1, 3). The soil application of organic nitrogen coming from treated wastewater reuse (this could represent a significant fraction of the total nitrogen application) shall be considered in order to ensure a balance between nitrogen crop demand and nitrogen supply from various sources. Monitoring of nitrogen contents in reclaimed treated wastewater used for irrigation in vulnerable zones is crucial to avoid over-fertilization. Measures to prevent nutrient pollution from runoff and downwards water movement in irrigation have to be put in place (see Annex II, point B.10 of the Directive).

Sewage Sludge Directive (86/278/EEC)¹⁶⁹

The provisions of this Directive are not directly relevant to the reuse of treated wastewater, however they should be kept in mind when developing any future legislation aiming to minimise health and environmental risks of water reuse in agriculture. There are, indeed, various common health and environmental issues raised by sewage sludge application and water reuse.

The Sewage Sludge Directive seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and human health. The objectives of the Directive may therefore share some similarities with the aims of future legislative measures concerning water reuse in agriculture.

According to the Directive, sludge must not be applied to soil in which fruit and vegetable crops are growing or grown, or less than ten months before fruit and vegetable crops are to be harvested, so as to provide protection against potential health risks from residual pathogens. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge. The Directive also requires that sludge should be used in such a way that account is taken of the nutrient requirements of plants and that the quality of the soil and of the surface and groundwater is not impaired. The Directive specifies limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils.

Consistency between this Directive and future policy measures on water reuse will deserve attention. The Directive might provide an interesting methodological framework for future legislation on water reuse, combining standards on the product (sludge vs. water to be reused)

¹⁶⁸ Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources

¹⁶⁹ Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture

and on spreading and land use provisions (to deal with accumulation of hazardous substances and nutrients balance in soils).

The Sewage Sludge Directive is currently under review.

Other EU legislation

Industrial Emissions Directive (IED) (2010/75/EU)¹⁷⁰

The IED is the successor of the IPPC Directive and in essence, it is about minimising pollution from various industrial sources throughout the EU. Operators of industrial installations operating activities covered by Annex I of the IED are required to obtain an integrated permit from the authorities in the EU countries. About 50.000 installations were covered by the IPPC Directive and the IED will cover some new activities which could mean the number of installations rising slightly.

According to the Directive, IPPC installations have to operate according to permit conditions based on Best Available Techniques (BAT). The BAT Reference Documents (so-called BREFs) adopted by the Commission set out what is considered as BAT at EU level, for a number of key industry sectors.

In several BREFs, water recycling is considered in the definition of BAT, but it usually refers to closed loop systems rather than the use of external supplied reclaimed water. The BREF covering the Industrial Cooling sector does explicitly mention as BAT the reuse of reclaimed municipal wastewater for the make-up of cooling systems.

The IED was due to be transposed into national legislation by Member States by January 2013. Since January 2014, the IED has become applicable to all new and existing installations, meaning that existing IPPC permits may need to be reviewed to ensure that they are in compliance with the IED. Where there are new activities included, for example, with wood preservation and shredding, these must be in compliance by January 2015.

Environment Impact Assessment (EIA) Directive (2011/92/EU)¹⁷¹

The EIA Directive establishes a procedure to ensure that the environmental implications of decisions concerning the development of projects are taken into account before the decisions are made. Certain types of projects that may typically involve water reuse are listed in the EIA. Activities listed in Annex I of the EIA Directive, which are subject to a mandatory EIA, include '*Groundwater abstraction or artificial groundwater recharge schemes where the annual volume of water abstracted or recharged is equivalent to or exceeds 10 Mm³*' (item 11). Activities listed in Annex II of the EIA Directive, which may be subject to an EIA upon decision of the competent authorities, include '*Water management projects for agriculture, including irrigation and land drainage projects*' (item 1.c) and '*Groundwater abstraction and artificial groundwater recharge schemes not included in Annex I*' (item 10.I).

¹⁷⁰ Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

¹⁷¹ Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment

Habitats Directive (92/43/EEC)¹⁷²

The Directive indirectly protects groundwater, in particular with regard to quantitative aspects. The requirement to maintain groundwater-fed habitats implies safeguarding groundwater flow in these areas. This requirement may favour the artificial recharge of aquifers with treated wastewater.

¹⁷² Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

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ANNEX E: Policy measures on water reuse in EU Member States

The table below provides an overview of policy measures implemented by EU Member States with regard to the reuse of treated wastewater, focusing on measures going beyond the current EU policy framework. The information is based on a literature review, complemented by the consultation of Member State representatives carried out as part of the present study. The table also contains information on implementation challenges and successes with regard to existing measures, where such information could be obtained. Further details concerning the national water reuse standards are presented in Annex B.

Member State	Type of policy measure	Scope	References and comments	Information sources
Belgium (Flemish Regional Authority)	Proposal for guidelines on water quality	Agricultural, non-potable urban, industrial, recreational and environmental uses	<u>AQUAFIN proposal to the government (2003)</u> , based on Australian guidelines. No further information on the outcomes of this proposal could be obtained to date. In the Flemish Region, within the context of sustainable water use, the focus is more on creating incentives for the use of rainwater than for the reuse of wastewater.	Wintgens T et al., 2006 Questionnaire reply from Flanders
Cyprus	Legislation on wastewater discharge (covering water reuse) + Code of practice	Irrigation	In Cyprus, water reuse provisions are fully integrated into the legislation on urban wastewater treatment and discharge (State Law N.106(I)/2002 , as amended). In general, all treated wastewater produced in Cyprus is reused, primarily for the irrigation of agricultural land, parks, gardens and public greens, where the Code for Good Agricultural Practice (K.D.P. 407/2002) is applied. This Code of Practice is intended to ensure further protection of public health and the environment (for each potential use, irrigation methods are indicated). As part of the transposition of the UWWT Directive and the IPPC Directive, Cyprus issued the State Law N.106(I)/2002 (amendments 2002-2009) concerning 'The Control of the Waters Pollution' and the associated regulations K.D.P. 407/2002, 772/2003 254/2003, KDP269/2005. According to this law, the operation of any establishment, which might cause or causes the pollution of the soil and/or the waters, is forbidden, unless it has Wastewater Discharge Permit. Wastewater Discharge Permits are issued by the Minister of Agriculture Natural Resources	Wintgens T et al., 2006 Medaware, 2005 Ioannidou, 2011 Papaïacovou, 2012 Questionnaire reply from CY

Member State	Type of policy measure	Scope	References and comments	Information sources
			and Environment for the Sewerage Boards and the Water Development Department. Permits specify the quality objectives and the disposal conditions of the treated wastewater for the agglomerations above 2,000 population equivalents (p.e.). Legally-binding numerical limit values are set for a range of parameters. They apply at the WWTP outlet. These values are different depending on the size of the WWTP (WWTPs serving urban and rural agglomeration above 2,000 p.e. or below 2,000 p.e.). Quality criteria for the treated wastewater take the specific conditions of Cyprus into account; in particular, conventional secondary treatment has been preferred to stabilisation ponds in some areas because of the high cost of land (coastal areas) or for protection of environmental and aesthetic amenities for tourism. In order to comply more efficiently with the guidelines, most of new projects under planning (new wastewater treatment plants as well as extension of existing ones) are beginning to consider advanced technologies such as membrane application, e.g. bioreactor technology (Larnaca, Limassol, and Nicosia) or reverse osmosis. Combined efforts by the Sewage Board and local governments to conduct periodic monitoring of water quality according to the regulation, has led to public acceptance and confidence in the use of reclaimed water.	
Cyprus	Legislation on reclaimed water prices		The current selling rates of the treated effluent have been set by the Council of Ministers, with the aim to incentivise consumption of treated effluent (treated effluent is less expensive than freshwater) (see further details in Section 2.6.2.1).	Questionnaire reply from CY
Denmark	Guidelines on water reuse	Main focus: non-potable uses	In 2014, the Danish government issued guidelines on water use in food businesses ¹⁷³ . The objective was to create clarity and possibilities within the current water-related regulation which is considered as relatively complex. In 2013, the government selected a consortium whose role is to make proposals for the development of national guidelines on reuse of water, which will be assessed and integrated in the official control of food businesses by the Danish Ministry of Food, Agriculture and Agriculture. The Danish Ministry of the Environment is currently offering funding of approximately 1 million euro to this consortium or partnership.	Danish Environment Ministry

¹⁷³ Vejledning nr. 9236 af 29. april 2014 om fødevarehygiejne, kap. 10 (Guidelines on Hygiene)

Member State	Type of policy measure	Scope	References and comments	Information sources
Finland	Legislation on irrigation water quality	Agriculture	No national regulations exist with regard to water reuse; however, irrigation water has to comply with quality criteria defined by Decree MMMa 1368/2011 (Annex 1).	Questionnaire reply from FI
France	Legislation on water reuse standards	Irrigation of crops and urban green spaces	<u>Ministerial Order of 2 August 2010 (as amended in June 2014)</u> Establishes four levels of quality, restrictions on uses, distances, land slope and origin of treated wastewater, includes monitoring requirements (at WWTP and on irrigated land) and information requirements, establishes the process to apply for a water reuse permit. Under Article 4, spray irrigation used to be only be authorised by local authorities for experimental purposes and under certain conditions. These provisions were modified in June 2014: the submission of an experimentation application file is no longer required but there are a number of specifications to be complied with when conducting spray irrigation (wind speed, setback distances, etc.). In 2012, the French Sanitary Agency (ANSES) conducted a study aiming at assessing health risks from the reuse of water using spray irrigation (for crops and green spaces) and for street cleaning. This study aimed at providing recommendations as part of a possible revision of the Ministerial Order. The ANSES suggested replacing the experimental study required by Article 4 (see above) by requirements on treatment levels and risk management measures (spraying at night, setback distances, etc.). With regard to water reuse for street cleaning, the ANSES considered that insufficient exposure data was available to assess potential risks for workers and pedestrians and recommended that exposure surveys be carried out. In order to comply with the Order, it was expected that most existing reuse schemes would have to upgrade their reclamation processes (by adding UV disinfection or membranes for example) within a year. Following the 2010 Order publication, the Working Group on Water Reuse (created by the French Scientific and Technical Association for Water and the Environment) recommended that technical assistance for water treatment industries should be provided in order for them to identify necessary upgrades and evaluate the costs. No evidence was found that such a study was effectively conducted. The Order led to a litigation when two companies specialising in the processing of animal by-products and organic waste took legal action to overturn it (reuse of wastewater from such installations is prohibited by the Order). In 2012, the State Council (the French highest administrative jurisdiction) rejected their action. Reportedly, the development of reuse schemes has been significantly slowing down since the	ANSES, 2012 ASTEE, 2010 Interview with representatives of French Environment Ministry

Member State	Type of policy measure	Scope	References and comments	Information sources
			Ministry of Environment initiated work on the water reuse Ministerial Order (in 2006). Indeed, potential developers preferred waiting for the regulation to be published before investing (feasibility studies cost around EUR 200k). However, even after 2010 (date of release of the Order), very few projects were developed because the Order was planned to be revised in order to tackle the issue of spray irrigation (an expert report was published in 2012 and the Order was revised in June 2014). Therefore, the only type of reuse scheme which is currently not on stand-by is irrigation for golf courses (such projects are seen as more economically attractive for investors and the investors concerned usually have a higher investment capacity).	
France	Economic instruments		River basin agencies have the possibility to provide funding to reuse projects. For example, the Clermont scheme (one of the most significant schemes in France) was partly funded by the Loire-Bretagne Water Agency.	Interview with representatives of French Environment Ministry
Germany	Legislation on reduction of wastewater discharges	Industry	<u>Federal Water Act</u> The federal Water Act, by setting provisions on the reduction of wastewater discharges, indirectly encourages the reuse of wastewater in the industry. According Art. 57 para 1 of the federal Water Act, the amount of wastewater has to be reduced as much as possible under consideration of the best available techniques. This provision has been implemented for different branches of industry, for example in beer brewing industry (with detailed regulation on allowed amount of wastewater per hectolitre) and brick manufacturing industry (no wastewater discharge allowed). These experiences are shared with other EU-member states within the Seville-process on the EU-Directive (2010/75/EU) and are presented on the internet platform "Cleaner Production Germany" under http://www.cleaner-production.de/en.html	Questionnaire reply from DE
Greece	Legislation on water reuse standards	Irrigation of agricultural areas, drinking water (after mixing with groundwater)	The legislative framework on water reuse includes two laws (ministerial decisions) and two circulars: 1. Ministerial Decision No 145116/Official Journal of the Government of Greece vol. B-354/8/3/2011, Specifying measures, conditions and procedures for the reuse of treated wastewater and other provisions. (Απόφαση Αριθμ. οικ.145116, "Καθορισμός μέτρων, όρων και διαδικασιών για την επαναχρησιμοποίηση επεξεργασμένων υγρών αποβλήτων και άλλες διατάξεις.", ΦΕΚ Β-354/	TYPSA, 2013 Questionnaire reply from EL Interview with The University of Crete

Member State	Type of policy measure	Scope	References and comments	Information sources
			8/3/2011) 2. Ministerial Decision No 191002/Official Journal of the Government of Greece vol. B-2220/9/9/2013, Modification of No. 145116/2011 Joint Ministerial Decision "Specifying measures, conditions and procedures for the reuse of treated wastewater (B 354) and related provisions" (Απόφαση Αριθμ. οικ.145116," Τροποποίηση της υπ' αριθ. 145116/2011 κοινής υπουργικής απόφασης «Καθορισμός μέτρων, όρων και διαδικασιών για την επαναχρησιμοποίηση επεξεργασμένων υγρών αποβλήτων (B' 354) και συναφείς διατάξεις", ΦΕΚ Β-2220/9/9/2013) 3. Circular 145447, 23-06-2011 of the Special Secretariat for Water,of the Ministry for the Environment, Clarifications on the correct application of Decision No 145116, B-354/ 8/3/2011. 4. Circular 1589, 03-11-2011 of the Special Secretariat for Water,of the Ministry for the Environment, Clarifications on the correct application of Decision No 145116, B-354/ 8/3/2011. <u>Joint Ministerial Decision 145116/11</u> The Greek government issued the first water recycling criteria in 2008, under which only the use of municipal wastewater subject to advanced treatment was permitted for unrestricted irrigation of agricultural crops. The new water recycling guidelines (2011) authorise additional uses of recycled water. Because the regulation is very recent, there is no information on its actual effects. The current rate of water reuse in Greece remains low. According to industry stakeholders, national standards remain too complex and too strict, which is a barrier to a wider uptake of water reuse solutions. Another key barrier is the limited public acceptance of farmers: most farmers agree to pay for reclaimed water that is used for irrigation of olive trees or other trees, but not for irrigation of vegetables or products that are intended to be eaten raw.	
Greece	Economic instruments	Irrigation of agricultural areas	Treated water from the largest water reuse project, in Thessaloniki, is provided free of charge to the farmers using it for irrigation.	Questionnaire reply from EL
Italy	Legislation on water reuse standards	Agricultural, industrial and non-potable urban uses	<u>Ministerial Decree 185/2003</u> Very restrictive standards (certain quality standards are similar to those for drinking water) with a high number of parameters to be monitored (> 50). Regional authorities may impose stricter norms for some parameters and a higher sampling	Presentation at CIS WG meeting of 12 Nov 2013 Questionnaire

Member State	Type of policy measure	Scope	References and comments	Information sources
			frequency. In Emilia Romagna and Puglia: microbiological standards are similar to those of the California Title 22 guidelines. In Sicily: microbiological standards are similar to those of the WHO guidelines. Reportedly, the level of stringency in certain regions has limited the potential in terms of promoting water reuse. According to a publication from the Environment Ministry, the provisions implemented through the Decree are well perceived by farmers. However, the following issues have been identified by the Italian Ministry of Environment with regard to the implementation of the Decree: - Limit values are relatively restrictive and costly to reach - Refurbishment of WWTPs is expensive as well as providing dedicated distribution infrastructure - It proves difficult to meet the continuously changing requirements of industrial end users - There is currently little flexibility with regard to the choice of treatment technologies. Reportedly, the government is considering a revision of this legislation, in order to reflect current knowledge of the human health risks in particular. The timeframe for this revision has not yet been determined.	reply from IT Interview with representative of Italian Environment Ministry
Sardinia Region (IT)	Water reuse management plans		A site specific treated water reuse management plan is required by the regional water reuse regulation (deliberazione della Giunta regionale n. 75/15 del 30 dicembre 2008) for each treatment plant (or group of plants). The aim is to ensure the involvement of all the actors (wastewater management and end-users), by creating a consortium and by consulting with stakeholders and local authorities. The plan shall specify: the actors involved; the water quality and control protocols; the volumes of treated water; the monitoring program for soil, agriculture and the environment; the financial plan; the cost-effectiveness analysis; and contingency plans.	Questionnaire reply from IT
Italy	Guidance		A methodology for assessing the technical and economic feasibility of treated wastewater reuse has been developed by ISPRA (Institute for Environmental Protection and Research) in 2012 (http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/modello-di-indagine-per-la-valutazione-della-fattibilita-del-riuso-delle-acque-reflue-depurate)	Questionnaire response from IT

Member State	Type of policy measure	Scope	References and comments	Information sources
Italy	Economic instruments	Industrial uses	<u>Decree 152/2006</u> Art. 155(6) of the decree orders that tariffs for industrial users be discounted to promote wastewater reuse for productive activities as a function of the volume of the reused water and of the quantity of fresh water used. <u>Ministerial Decree 185/2003</u> Requires the free supply of treated wastewater from WWTP to the distribution network, as well as adequate cost recovery for the distribution of treated wastewater. <u>Public-private partnerships</u> have been put in place to finance certain reuse schemes (e.g. in Venice) <u>The National Irrigation Plan adopted by the Ministry of Agriculture</u>: promotes treated wastewater reuse for irrigation and finances irrigation infrastructure including for reused water.	Questionnaire response from IT
Malta	Water supply and wastewater discharge regulations Water reuse standards under development Regulation on reclaimed water prices	Irrigation, industry	Re-use of treated sewage effluent is an important consideration in Malta's overall strategy for sustainable water use. The current regulatory framework in relation to the treatment and re-use of sewage effluents is however limited. In fact, reference is made to the following legislation: (i) the Water Supply Regulations (S.L.423.03) which establishes the charge which the public utility, the Water Services Corporation can apply for supplies of treated sewage to potentially irrigable land at 83.86 EUR/ha/yr and to the industrial sector at 0.093 EUR/m³; and, (ii) the Sewer Discharge Control Regulations (LN139/02; as amended), which regulates the discharges of contaminants to the sewers, with the aim of amongst others protecting the re-use function of sewage. Guidelines on water reuse, including quality standards, are currently being drafted. New regulatory measures to guide the production and use of treated sewage effluents are being considered by Government under the frame of the development of a National Water Management Plan for the Maltese Islands. This plan will seek the integrated use of water supply augmentation and water demand management measures to address the islands' chronic water scarcity conditions. It is further noted that under this management plan, the utilisation of polished treated effluents will be considered for a wide range of uses including the managed artificial recharge of aquifer systems. The implementation of the UWWT Directive has seen the commissioning in recent years of	Questionnaire reply from MT

Member State	Type of policy measure	Scope	References and comments	Information sources
			three new WWTPs (the Ras il-Hobz WWTP, the Cumnija WWTP, the Ta' Barkat WWTP), which together have the capacity to treat all the wastewater produced in the Maltese islands prior to its discharge to the sea. Due to the persisting problems associated with the high salinity of the treated effluent, the development of further polishing facilities (ultra-filtration followed by brackish water desalination) for the effluent to ensure the attainment of the quality levels required for its re-use is envisaged. In addition to the development of polishing plants, it is planned to: - Upgrade and rehabilitate the sewerage network (particularly in those areas where the network is located below sea-level to reduce the direct intrusion of sea-water in the network); - Continue to improve the regulatory structure to monitor discharges to the sewerage network with the aim of reducing both the discharges of brines and also of industrial and other organic contaminants; and - Development a dedicated second class water distribution system to deliver the polished effluent to the point of use. These effluent polishing and distribution facilities are still being developed; therefore, there is no information on the implementation of water reuse actions included in the National Water Management Plan.	
Malta	Public information measures and other measures		In Malta, most of the implementation concerns relate to the eventual quality of the polished effluent. Indeed, past experience with the Sant'Antnin Plant was not unsuccessful because the high level of salinity of the effluent resulted in the low quality of crops irrigated with this water. Therefore, Malta has to ensure public acceptance of its future reuse projects and thus considers the development of a publicly available information system on the quality of the treated effluent. Another foreseen implementation issue is linked to the development of a dedicated distribution network to deliver the treated effluent to the point of use. Indeed, the high level of land fragmentation in the Maltese islands results in a high density of potential users. Schemes and negotiated agreements to incentivise irrigators to use polished effluents instead of groundwater are still being formulated.	Questionnaire reply from MT

Member State	Type of policy measure	Scope	References and comments	Information sources
Portugal	National standard for reuse of reclaimed water for irrigation + Guidelines for the production and distribution of treated wastewater + Technical Guide on the Reuse of Treated Wastewater + National Strategic Plan (PEAASAR II) + Water reuse target		<u>National standard for reuse of reclaimed water for irrigation - NP 4434:2005</u>, released by the National Standards Institute (IPQ) in 2005 The standard applies to agricultural and landscape irrigation and is based upon two principles: the agronomic quality of reclaimed water must comply with the FAO guidelines and the microbiological quality criteria of reclaimed water for irrigation should take into consideration the multiple barriers to plant-soil-groundwater and surface water contamination. Microbiologic quality and public health standards are based on the WHO guidelines. The scope of the standard is not limited to the specification of quality criteria for treated urban wastewater for irrigation: it also includes guidelines for selection of irrigation equipment and methods as well as guidelines for environmental protection and environmental impact monitoring in areas irrigated with treated urban wastewater. <u>Rec.IRAR nr 2/2007 Use of treated wastewater: Guidelines of the National Regulator for water supply, wastewater and wastes services</u> (nowadays ERSAR, formerly IRAR) (2007) Guideline for the production and distribution of treated wastewater for irrigation. Covers quality control, although it does not specify the requirements. Also sets a basis for calculating the water price and who should pay it. <u>Technical Guidance on the Reuse of Treated Wastewater</u>, released by the Regulator Authority for Water Supply, Wastewater and Wastes Services (ERSAR) in 2010 This guidance aims at providing the public with a supporting tool for the implementation of reclaimed wastewater reuse projects. It is intended for all water industry professionals, particularly organisations in charge of public urban wastewater systems and drinking water supply systems, river basin region managers, public health authorities, tourism operators and other public and private organisations interested in the implementation of wastewater reuse projects. The guidance focuses on the wastewater quality aspects that affect the reuse in several applications: irrigation, non-potable urban environmental and recreation applications, etc. The legal and institutional issues related to the implementation of water reuse projects, the economic and financial viability aspects and public participation and acceptance of water reuse projects are also covered. The development of this guidance was motivated by the growing interest of wastewater operators in engaging in water recycling activities. Water recycling went from a non-core activity to an attractive business due to a growing market for water, requiring further attention	AFEID, 2012 Albuquerque, 2011 SIMTEJO, unknown date Questionnaire reply from PT Interview with ISEL (Instituto Superior de Engenharia de Lisboa)

Member State	Type of policy measure	Scope	References and comments	Information sources
			from the regulator. <u>Water reuse permits</u> All reclaimed water reuse projects must have a permit issued by the Portuguese Environmental Agency (APA); the permit is issued based on the analysis of the reuse project, including the water quality control procedures, the water application protocol, the agreement of the Health Authorities in the case of public spaces irrigation, etc. Simtejo, the company responsible for treating wastewater in the region of Lisbon and leader of many reuse projects, sees the permitting process as a constraint in setting up and operating reuse schemes. <u>National Strategic Plan (PEAASAR II)</u> In 2010, more than 70% of the Portuguese population was connected to WWTPs. The goal of PEAASAR II were as follows: - 90% of the population connected in 2013, representing ≥ 500 million m³/year of treated UWW - ≥ 10 % of treated wastewater reused by 2013 (i.e. ≥ 50 Mm³/y) relying on schemes with high potential of reuse, including golf courses. However, this target was not achieved. An assessment was made and showed that only 1% of treated wastewater was actually reused. NB: Portugal water demand is estimated at 7,500 Mm³/y, of which 6,550 Mm³/y is used by agriculture. Measures to support the achievement of the target included: a strategic plan for water supply and wastewater for 2007-2013; a national plan for the efficient use of water; and a guidance document for implementing water reuse projects (mainly for agricultural and landscape irrigation uses). The new Strategic Plan for Water Supply and Waste Water for 2014-2020 is expected to include a new target for water reuse. <u>Information on the evaluation of policy measures</u> The awareness in Portugal for the need for an efficient water usage has risen increasingly from 2000. The economic component is usually the first to trigger the need for resource efficient use, but environmental awareness has also increased substantially, trying to reverse the strong pressure over the aquatic systems. The National Program for Water Use Efficiency	

Member State	Type of policy measure	Scope	References and comments	Information sources
			(PNUEA) refers to water re-use as interesting alternative. Despite the increasing awareness, the level of re-use is still very low (currently around 1% of treated wastewater). Main obstacles are: • A general lack of knowledge and negative public perceptions with regard to food products irrigated with reclaimed water. • The high cost of transportation of the water from WWTPs to irrigation fields, and therefore a low cost/ effectiveness. Farmers and golf courses are the main treated wastewater users and are usually far from WWTPs. Some municipalities reuse water for public gardens irrigations, but it is common understanding that this option is only viable if a WWTP is located within close vicinity. • The low price of freshwater for agriculture does not make water reuse an attractive alternative in most cases. • The lack of financial incentives. Some municipalities are slowly preparing a parallel distribution system for reused water, but it is usually only affordable when they make repairs in the main pipeline. Therefore, the network is not being built in a continuous way. • Investment costs for reuse projects: water reuse projects often require significant financial investments and it is difficult to assess the cost effectiveness of these projects. • A lack of political involvement (water reuse is not seen as a priority at the moment). • Administrative burden: it is very difficult to obtain a water reuse license in Portugal. Several projects were submitted to the competent authorities but were rejected. • Heterogeneity in water scarcity in Portugal: not all regions face water scarcity issues, hence the awareness on the need to reuse water is not shared by all stakeholders. Experience shows that the level of information and knowledge is a very decisive factor. In Portugal, the University of Aveiro has a strong expertise in water use. They have several projects with the surrounding municipalities and it is the area of Portugal where more efficient water use, including water reuse, is occurring, with changing behaviours. Faro, a municipality of the south of Portugal, has also a strong and successful policy regarding efficiency and water re-use. They have a close link with the University of Aveiro. LNEC, APA (former INAG), Univ. Og Agronomy and ERSAR have produced a lot of	

Member State	Type of policy measure	Scope	References and comments	Information sources
			information and guidance on water reuse, but the close work with the municipalities proves to be the most efficient awareness raising method.	
Spain	National legislation on water reuse standards + National guidelines + Regional legislation or guidelines	Agricultural, industrial, non-potable urban, recreational and environmental uses	<u>Royal Decree 1620/2007</u>, based on the WHO guidelines from 1989 with additional restrictions. More comprehensive guidelines were developed by certain regions (Andalucia, Balearic Islands and Catalonia). The RD 1620/2007 establishes 24 uses for reclaimed water that are grouped into five broad categories: urban, agricultural, industrial, recreational, and environmental. The decree also establishes a series of prohibited uses, among which water for human consumption. Annex I of RD 1620/2007 lays down the required quality objectives, which are defined by a set of maximum acceptable values for a series of parameters relevant to different water uses. In addition, in order to assess compliance with quality requirements, it establishes a self-monitoring programme to be carried out at the outlet point of the reuse system. According to the Spanish Ministry of the Environment, the Royal Decree has played a crucial role in promoting and improving water reuse practices as essential parts of the integrated management of water resources. Because the Decree regulates a wide range of end-uses, it makes investing in water recycling a cost-effective activity: many users benefit from the reclaimed waters of a single reuse system. However, the stringent quality standards and permitting procedure reportedly may represent a disproportionate burden for the smaller project developers and tends to prevent them from engaging in water recycling activities. Following the publication of the abovementioned Royal Decree, Spain elaborated the "<i>Guide for the implementation of RD 1620/2007 laying down the legal framework for the reuse of treated water</i>"¹⁷⁴. This guide provides recommendations on procedures and criteria for the application of the Royal Decree, so that water reuse is implemented according to best practices while ensuring the safety of the general public, customers and employees. The implementation of water reuse schemes enables Spanish WWTP operators to reduce their wastewater discharge fees, as a consequence of reduced volumes of discharged wastewater and a potentially higher quality of the discharged water. The -urgent environmental measures- law approved by Spain's government in May 2012 included a clause specifically creating exceptions to the application of the full cost recovery for	Alcalde-Sanz et al., 2014 World Water, 2011 Questionnaire reply from ES

¹⁷⁴ http://www.magrama.gob.es/es/agua/temas/concesiones-y-autorizaciones/GUIA_RD_1620_2007_tcm7-178027.pdf

Member State	Type of policy measure	Scope	References and comments	Information sources
			water-related services; such a clause may contravene the promotion of water reuse. In order to promote reuse activities, the use of reclaimed water is an obligation in some regions and for specific uses. For instance, in Madrid it is compulsory to use reclaimed water to irrigate golf courses. The same requirement exists in Andalucía. In other regions, reuse of treated water is not compulsory but it is highly recommended, e.g. for industrial uses in the Region of Madrid.	
Spain	National Plan for Water Reuse		Spain has developed a National Plan for Water Reuse (NPWR) which is currently pending approval. It aims at developing the legal framework for water reuse through initiatives or plans by public administrations, recognising that water reuse projects are often driven and encouraged by local authorities. For instance, local regulations in the regions of Murcia and Andalucía strongly supported the development of water reuse systems to irrigate golf courses in these regions. The National Plan also intends to promote R&D and information dissemination. The Spanish Environment Ministry plans to create a specific page dedicated to water reuse on the Ministry's, with the objective to disseminate experiences and good practices in this field as well as scientific and technical knowledge about water reuse. This is expected to increase public acceptance of water reuse. More specifically, the objectives of the plan are as follows: - Contribute to the achievement of a good status of waters by 2015, as per the WFD. - Promote the establishment and maintenance of ecological flow regimes. - Accomplish, as much as possible, a zero discharge of direct discharges to the sea. - Establish an adequate financial model to promote the sustainable reuse of waters for agricultural, environmental, recreational, industrial, and urban uses, not affecting the environment, safety, and health, considering economic costs and available technology. - Promote Good Practices in water reuse - Provide information, raise awareness and consciousness of the benefits of water reuse. - Encourage research, development, and technological innovation of water recycling treatments. The plan includes the following key action areas:	World Water, 2011 Questionnaire reply from ES Presentation from the Spanish Environment Ministry at the 25th Water Reuse Symposium , 2010¹⁷⁵

¹⁷⁵ Available at: <https://www.watereuse.org/sites/default/files/u3/Plan%20Nacional%20%5BCompatibility%20Mode%5D.pdf> (accessed 28.08.14)

Member State	Type of policy measure	Scope	References and comments	Information sources
			- Development of the legal framework for water reuse through initiatives or plans by public administrations. - Identification and construction of the infrastructures necessary to achieve the objectives set in the Plan. - Drafting a Guide of Good Practices in Water Reuse. - Promotion of research, development, and innovation actions. - Dissemination of information, communication and public participation. The estimated budget to implement this plan was EUR 650m (as estimated in 2010).	
Spain (Catalonia)	Targets and Water Reuse Programme	Various uses	The Catalan Water Agency intends to reach the goal of 200 million m³ of reused water by 2015, which would mean that 31% of treated water would be reused. In order to reach this target, the ACA set up a Water Reuse Programme¹⁷⁶. With this aim, the programme sets out: the reuse infrastructure to be promoted by the Government of Catalonia; the definition of uses that are considered most appropriate for each treatment system; the proposal for a new management framework for this activity to allow it to be better developed, including the definition of the financing criteria for the different actions and mechanisms through which to recovery public expenditure on investment and exploitation; and the establishment of quality criteria for reclaimed water in addition to automatic control measures. The programme lists the reuse actions that are to be carried out in the coming years, both those that will be promoted by the Agency as actions considered to be in the general interest and those that will be carried out by other bodies. The programme anticipates a total investment of EUR373m (EUR330m of which are allocated to carrying out 51 projects promoted by the Agency) in the actions required in order to allow the reuse of almost 31% of the annual flow treated in treatment plants and 50% of the flow treated in the summer months, equivalent to 229 million m³/year of reclaimed flows, with a production (excluding refuse) of 204 million m³/year.	Website of the Catalan Water Agency (ACA)

¹⁷⁶ Available at: http://aca-web.gencat.cat/aca/documents/ca/planificacio/reutilitzacio/PRAC_V_3_1.pdf (accessed 28.08.14)

Member State	Type of policy measure	Scope	References and comments	Information sources
Spain (Costa Brava)	Economic instruments	Various uses	<u>Regulation allowing exemption of the user tax for reclaimed water in Costa Brava:</u> The Catalan Water Agency has approved a new tax (0.1498 EUR/m³) that applies to the use of drinking water used by the municipalities. Because this tax does not apply to reclaimed water, it can result in an additional incentive for the municipalities to develop usable local resources such as reclaimed water.	Wintgens T et al., 2006 Sala, 2013
United Kingdom	Economic instruments	Industrial uses	In 2006, the Government added water reuse with membranes to the scope of Enhanced Capital Allowances (ECA) scheme that provides financial incentive for industry to reuse wastewater through tax reductions under the previously applied scheme for energy efficiency schemes (non-fossil fuels etc.). This ECA scheme already covers water saving devices and rainwater harvesting.	Angelakis et al., 2007

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ANNEX F: Preliminary analysis of suitable policy instruments for implementing Option 2

In theory, legally-binding EU standards on water reuse (Option 2) could be implemented either through a Regulation or a Directive.

The IA of the Blueprint concluded that a Regulation would be a suitable instrument as it would guarantee that internal market barriers to the trade of agricultural goods would not arise (unlike in the case of indicative water reuse standards). In order to avoid potential trade issues for food products, it is essential that MS should not be tempted/allowed to impose more stringent requirements at the national level, for environmental or health protection reasons. At this stage, it is unclear whether a Regulation on common standards could fully achieve this objective¹⁷⁷.

The Blueprint IA also considered that a Regulation would have lower burdens on MS as it would not require transposition, and would be fully coherent with other EU water law and policy. Establishing a Regulation would however require a high level of consensus among the MS.

A Directive would give more flexibility to MS, with the possibility to account for national specificities and, in particular, adapt the standards that are already in place in some MS (where such standards have proved successful). However, it would not solve the potential internal trade barriers. With a Directive, it would be easier to align the approach of the water reuse standards with other EU water quality-related Directives, especially the Drinking Water Directive which is being revised. EU water policy already includes many Directives that contain provisions on quality standards and/or the implementation of risk management plans. Some examples are highlighted in the box below.

¹⁷⁷ A parallel can be established with the EU food safety legislation: MS have implemented national legislation in addition to the various EU Regulations.

Box 5: Examples of Directives including provisions on quality standards and/or the implementation of risk management plans in the field of water

The **Drinking Water Directive** (98/83/EC) provides in its Article 5 that MS must set values applicable to water intended for human consumption for the parameters set out in Annex I (these include microbiological and chemical parameters); a Member State may set values for additional parameters when required to protect human health within its national territory or part of it. Annex I also lays down 'indicator parameters', whose values need to be fixed only for monitoring purposes and for the fulfilment of the obligations relating to remedial action and restrictions in use. The Directive is currently being revised; a risk-based approach is being considered as part of this revision.

The **Environmental Quality Standards Directive** (2008/105/EC, as amended), daughter directive of the WFD, lays down the environmental quality standards that MS must apply for those substances listed on the priority substances list.

The **Bathing Water Directive** (2006/7/EC) lays down specific parameters (intestinal *enterococci* and *E. coli*) which must be monitored to ensure the quality of all bathing waters.

The **Freshwater Fish Directive** (2006/44/EC) determines physical and chemical parameters applying to designated salmonid and cyprinid waters (Annex I). MS must set values for these parameters, Annex I including both guide and mandatory values.

The **Floods Directive** (2007/60/EC) requires the establishment of flood risk management plans (Article 7 and Annex). The Annex lists the key components of the plans and key aspects of their implementation.

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