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STUDY ON WATER EFFICIENCY STANDARDS

Final Report

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Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health

Bio Intelligence Service S.A.S - bio@biois.com
20-22 Villa Deshayes - 75014 Paris - France
Tél. +33 (0)1 53 90 11 80 - Fax. +33 (0)1 56 53 99 90

Contact BIO Intelligence Service
Shailendra Mudgal – Patricia Benito
☏ + 33 (0) 1 56 20 28 98
shailendra.mudgal@biois.com
patricia.benito@biois.com

Project Team

Bio Intelligence Service

Mr. Shailendra Mudgal

Ms. Patricia Benito

Mr. Vincent Jean-Baptiste

Ms. Débora Dias

Ms. Mary Ann Kong

Cranfield University

Mr. David Inman

Ms. Melanie Muro

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EXECUTIVE SUMMARY

Background

Water scarcity and droughts affect many parts of Europe. Climate change and population growth are predicted to make the existing water problems even worse in many regions. In recognition of the acuteness of water scarcity and drought challenges, the European Union has adopted a Communication addressing the challenge of water scarcity and droughts. The Communication provides a fundamental and well-developed first set of policy options for future action, within the framework of EU water management principles, policies, and objectives. The Commission is exploring the ways in which the European Union can address water scarcity and droughts and a number of recommendations were made in the Communication in this regard. Amongst the various identified policy options, one of them suggests analysing the potential of water efficiency standards for Water-using Products (WuPs) at EU level. This option needs further assessment in terms of feasibility and implementation, which is the subject of this study.

Objectives and methodology

This study aims to analyse the need for introducing water efficiency standards for water-using devices at the EU level and to discuss the potential advantages and disadvantages of such an approach based on existing evidence in EU Member States (MS) and beyond.

Stakeholder consultation was carried out targeting MS and other relevant stakeholders to collect information on existing specific regulations or programmes at the national or sub-national levels within and outside Europe, which introduce water efficiency requirements. This was achieved through a dedicated questionnaire and a website. A number of interviews were also conducted with a range of experts and other key stakeholders (e.g. research institutes). A desk study of existing relevant publications and internet sources was also carried out.

Identification of WuPs and classification

The first step was to provide a general definition of a WuP, followed by the development of a list of WuPs for different sectors (buildings, industry, and agriculture), and their prioritisation of WuPs. Based on whether the product is widely used in the EU, and its use patterns, potential for improvement, water efficiency, and market trends, prioritisation was needed for a number of different products in the household sector in Europe. The most important products are those used for sanitation, laundry, washing and outdoor applications. In particular, it was estimated that WCs, showers, taps, washing machines, and dishwashers contribute to 31%, 33%, 10%, 11%, and 3% of average household water use respectively. On the other hand, outdoor water consumption (e.g. garden irrigation, cleaning equipment) represents approximately 3% of average household water use.

In terms of water saving potential, by reducing current stock with more efficient products, dishwashers represent the greatest potential of 55%, followed by toilets of 53% (including both long and short flushes), and washing machines of 32%. Replacing all standard residential WuPs (taps, toilets, showers, baths, washing machines, dishwashers and outdoor products) by water efficient products would result in an overall decrease in yearly water consumption of around 32%, or 40 716 litres for an EU household.

In comparison to water consumption data for typical household and commercial sectors, figures available for industrial water consumption are either scarce or too industry-specific. Therefore, this study focused on the products which are widely used across different industries, viz. cleaning, steam generation, and cooling equipment. It is noted that during the past few years, the overall water consumption in industry has fallen throughout Europe. This has mainly been due to the decline of industrial production, the use of more efficient technologies with lower water requirements, and the use of economic instruments (charges on abstractions and effluents). This may suggest that a policy intervention in the case of WuPs of the industrial sector may not be as effective as for household and commercial sectors.

In the case of agricultural WuPs, one major challenge is the difficulty in determining how to measure the water efficiency of irrigation systems and comparison of different systems. The water efficiency is less dependent on the irrigation equipment itself by rather on the management practices employed by the end user. Therefore, to determine the water efficiency of irrigation systems in a realistic manner, a system level analysis of the management practices (and not the individual products) would be required, which is beyond the scope of this study.

- **Existing policy instruments**

At EU level, the Council Directive 92/75/EEC on the labelling and standard product information of the consumption of energy and other resources by household appliances stipulates the energy labelling requirements of household washing machines and dishwashers and also introduces some water performance requirements.

During recent years, the EU established water consumption criteria under the EU Eco-label for different appliances such as dishwashers and washing machines. However, no washing machine and only one dishwasher has ever been awarded the label. Both washing machines and dish washers are also covered by the Ecodesign Directive (2005/32/EC), and working documents on a possible Commission regulation implementing this Directive with regard to household washing machines and dishwashers (setting water requirements for washing machines and benchmarks for best-performing products for dishwashers) have undergone inter-service consultation (March 2009). In a recent policy development, in April 2009, a legislative resolution was adopted by the European Parliament and Council to widen the scope of the

Ecodesign Directive to include energy-related products. This category includes products that do not consume energy during use but have an indirect impact on energy consumption, such as water-using devices. This means that in the near future some WuPs such as water-saving taps, shower heads, and cleaning equipment will be addressed through the Ecodesign Directive.

At the national level, different initiatives exist within EU and in third countries (e.g. Unites States, Australia) which introduce water efficiency requirements, particularly for household and commercial WuPs such as showers, dishwashers, washing machines, urinals, taps and tap outlets, toilet suites and matching-set cisterns, and flow regulators. Quite often, such requirements are associated to a Water Efficiency Labelling Scheme (WELS) such as the schemes in Australia, WaterSense in the United States, and Waterwise in the United Kingdom. It is also observed that water efficiency labelling has only been around for a decade.

In EU, many MS have eco-labels, such as the Blue Angel in Germany and the Swan in the Nordic countries, which are awarded to products for overall environmentally-friendliness and some labels sometimes take into account water consumption. However, they tend to focus more on sustainable materials use (e.g. sustainable tissue paper) or minimisation of pollution (e.g. eco-friendly detergents). Taps, flushing toilets, and many other WuPs are often not included in these eco-label schemes.

At the international level, most initiatives that regulate water performance of WuPs exist in the United States. The concept of WELS is quite prevalent in the Asia-Pacific region and is in different stages of development (Australia, Singapore, New Zealand, and Hong Kong). In some countries, it is a mandatory requirement to provide water efficiency labels for certain WuPs before they can be put on the market. For others, WELS exists is on a voluntary basis so as to allow a lead time for the market to transform towards more water efficient products (as is the case in Hong Kong and for certain products under the Singapore WELS).

- **Gaps and limitations of existing schemes and programmes**

Most of the existing schemes are observed to be in countries concerned by water shortage and drought problems (Italy, Spain, Portugal, Australia, etc.).

Within EU, there appears to be no scheme equivalent to the Australian WELS. Most markings systems indicating the water efficiency of a certain product or service consisting of certificates or quality endorsements. Most of the mandatory schemes either have a local coverage (Spanish and Italian schemes) or target only specific WuPs such as toilets (United Kingdom and Ireland Building Regulations).

No scheme or programme has been identified which introduces water efficiency requirements for industrial equipment and irrigation systems used in agriculture, except programs promoting water savings in specific industrial sectors. For instance, in France the local authorities in charge of water (Agences de l'Eau) financially support industries which develop water saving management plans. However, due to the diversity of products used in industrial settings, there are no specific requirements.

➢ **Need for an EU approach, analysis of policy options, and future work**

Most existing measures focus on a handful of WuPs, mainly in residential and commercial buildings.

Although the conditions of water resources management in Europe are very different due to climate, precipitation, population, land use, etc., introducing a common approach and requirements at EU level will contribute to setting basic minimum standards which would have to be fulfilled all over Europe. Thus, it would establish a level playing field for manufacturers across all the sectors and would harmonise targets and strategies to achieve water efficiency.

Similarly to energy efficiency, different policy options could be considered to address the water efficiency of products. In order to determine the most appropriate policy option to address water efficiency for WuPs at the EU level, different options were considered and evaluated quantitatively and qualitatively.

Four different policy options have been analysed for EU Policy action:

1. Setting mandatory water consumption requirements for key WuPs through the extended Eco-design Directive.
2. Introduction of a voluntary endorsement label.
3. Introduction of a mandatory ranking-type label.
4. Introduction of voluntary agreements.

The potential water savings for each of these options were weighed quantitatively and further compared to a no further action scenario (Business-As-Usual).

The analysis suggests that through the extended Eco-design Directive, reductions in public water supply could potentially reach as high as 19.6%. This equates to a 3.2% reduction from the annual total EU water abstraction. As the implementation of legislative water saving requirements for dishwashers and washing machines is already underway, their potential savings may be discounted from this total. Savings could potentially amount to 14.8% of the public water supply (or approximately 2.4% of total EU abstraction).However, if the savings for energy-related products are taken into account exclusively (again, disregarding dishwashers and washing machines), actual reductions from public water use would be approximately 6% (1% of total abstraction). Due to the possible varying market distributions of water saving products, introducing a ranking label would result in savings that fall within a range. This range was determined at 7.3 to 12.1% reduction from public water use (excluding dishwashers and washing machines). This range falls below the potential reductions that could result from the introduction of mandatory requirements. However, even the lowest estimate is higher than the introduction of mandatory requirements exclusively for energy related products (stated above at 6% of public supply). Either of these options results in considerably higher savings in comparison to both the introduction of a voluntary endorsement label and the Business-As-Usual scenario. These options could potentially result in reduction of 0.7 and 1.5% from public water supply, respectively (or 0.03% and 0.2% reduction from total EU water abstraction).

These results suggest that the introduction of mandatory requirements for minimum water efficiency of products through the extened Ecodesign Directive would have a significant potential for the reduction, of the environmental impact of these products. Furthermore, it would be the most cost-efficient and feasible option from a legislative point of view as the recent extension of the Ecodesign Directive to cover energy-related products provides an adequate legislative framework for setting compulsory minimum efficiency requirements for WuPs.

Furthermore, reducing the water consumption of energy-related products such as taps, showers and baths (as agreed in the recent extension of the Directive), will also indirectly result in the reduction of energy consumption by 20% a reduction in the hot water needs of these products. This would lead to a reduction in energy use of 18.4 TWh/year**.** This represents savings of 0.50% of total EU primary energy supply. Reducing energy use would in turn result in yearly CO_2 savings of approximately 2.89 $MtCO_{2eq}$ if standard energy-related WuPs are replaced (excluding dishwashers and washing machines).

The revised Ecodesign Directive may not cover other WuPs that are not energy-related, but still having a significant contribution to the total water consumption of buildings and a large potential for improvement (such as toilets). Therefore, complementary measures will be needed to tackle these products.

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ABBREVIATIONS

ANSI	American National Standards Institute
ANQIP	National Association for Quality in Building Installations (in Portugual)
ASME	American Society of Mechanical Engineers
BATs	Best Available Technologies
BMA	Bathroom Manufacturers Association (United Kingdom)
CAP	Common Agricultural Policy
CECED	European Committee of Domestic Equipment Manufacturers
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CIP	Cleaning in Place (devices)
CODEMA	City of Dublin Energy Management Agency
CVA	Cistern Volume Adjuster
DRWCP	Dublin Region Water Conservation Project
EBMUD	East Bay Municipal Utility District (Unites States of America)
ECAs	Enhanced Capital Allowances
ETSI	European Telecommunications Standards Institute
US EPA	United States Environmental Protection Agency
EuPs	Energy-using Products
FAO	Food and Agriculture Organization (UN)
GDP	Gross Domestic Product
GEN	Global Ecolabelling Network
Gpv	Gallon-per-vehicle
HETs	High-Efficiency Toilets
IBA	In-Bay Automatic Car Wash
MaP	Maximum Performance (programme in United States and Canada)
MCA	Ministry of Consumer Affairs (New Zealand)
MPS	Minimum Performance Standard

MTP	Market Transformation Programme
NACE	Nomenclature des Activités Economiques dans la Communauté. Européenne
NECPA	National Energy Conservation Policy Act (Unites States of America)
OECD	Office of Community and Economic Development
PCC	Per Capita Consumption
PRODCOM	PRODucts of the European COMmunity
PS	Place Settings
PUB	Public Utilities Board
RGAAR	General Regulation for Water and Drainage of Residual Waters in Public and Residential Building Systems (in Portuguese)
SEC	Singapore Environment Council
SS	Singapore Standards
SWAT	Smart Water Application Technology (programme)
TBCSD	Thailand Business Council for Sustainable Development
TDS	Total Dissolved Solids
TEI	Thailand Environment Institute
TISI	Thai Industrial Standards Institute (Thailand)
TS	Technical Standard
UNAR	Unified North American Requirements
WELS	Water Efficiency Labelling Scheme
WEI	Water Exploitation Index
WSAA	Water Services Association of Australia
WuPs	Water-using Products

1. GENERAL BACKGROUND

1.1. REPORT STRUCTURE

This document is the final report of the study on “Water efficiency Standards” commissioned by DG Environment (Service Contract 070307/2008/5208889/ETU/D2). The main objective of this study is to present an analysis of existing water efficiency standards in Europe and third countries and the need and feasibility for EU efficiency standards for WuPs. It is based on a literature review and stakeholder consultation through questionnaires and personalised interviews.

Chapter 1 provides a general background to this study, in particular introducing the water scarcity problem in Europe, water abstraction and use trends, and existing policy actions at EU level which address the efficiency of water use in different economic sectors.

Chapter 2 introduces the main goals of this study and the adopted approach and methodology.

Chapter 3 defines the scope and general classification of different types of WuPs, including information on their water consumption, improvement potential, and use patterns.

Chapter 4 includes an inventory of different standards, schemes, programs, and other policy instruments that regulate the water performance of WuPs identified across Europe and beyond.

In Chapter 5, the effectiveness of existing instruments is analysed, as well as major synergies and inconsistencies in existing water efficiency standards. The assessment also focuses on the benefits and limitations of the different policy types and both the outcomes as well as the impacts of the investigated policy instruments. It also presents some real-life case-studies of existing standards that have proven to be efficient in improving water performance of WuPs.

Chapter 6 analyses whether the introduction of water efficiency requirements for WuPs at the EU level would deliver further benefits in comparison with the current situation (business as usual) and then suggests the potential impacts. Also, it identifies the WuPs that are the priority to be addressed at the EU level.

Chapter 7 presents the main conclusions and the advantages of a possible EU approach and possible barriers. It also includes recommendations for the option that could be the most feasible and needs future work.

1.2. WATER SCARCITY IN EUROPE: A GROWING CONCERN

Water scarcity and droughts affect many parts of Europe. A recent survey (European Commission, 2007) highlighted that 33 river basins in 13 Member States (MS) are already affected by water scarcity. These are not limited to Southern Europe, but also include basins in Belgium, Denmark, Germany, Hungary, and the United Kingdom. Droughts have occurred with increasing frequency over the past 30 years. Since 1989, severe events have affected more than 800 000 km² across 27 MS of the European Union (EU) (37%) and 100 million inhabitants (20%) in four separate years (in 1989, 1990, 1991, and 2003). It has also been estimated that at least all Mediterranean MS (Cyprus, Malta, Italy, Spain, Portugal, and Greece) are impacted by water scarcity, with a total affected population of 130 million inhabitants (27% of the EU-27 population).

Climate change and population growth are predicted to make the existing water problems even worse in many regions. Indeed, climate change is expected to reduce water availability and increase irrigation withdrawals in Mediterranean river basins. Under mid-range assumptions on temperature and precipitation changes, water availability is expected to decline in southern and south-eastern Europe (by 10% or more in some river basins by 2030).

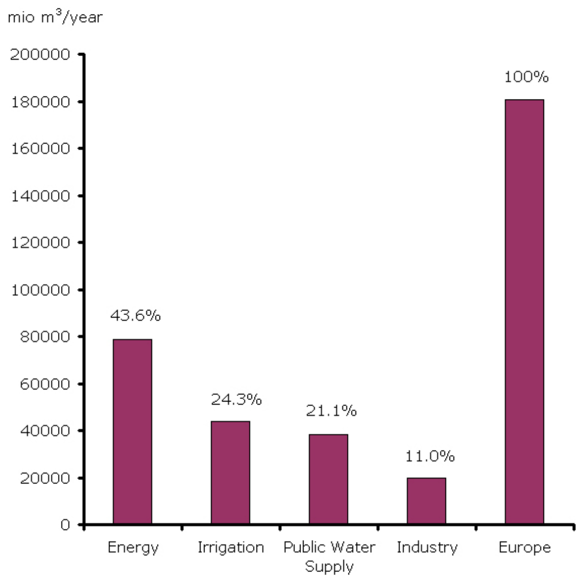
Significant economic impacts of water scarcity and droughts can be expected on the agricultural sector because of the high demand for water for irrigation, and on power generation because of cooling water requirements. The widespread drought of 2003 incurred damage costs of at least €8.7 billion to the EU economy. It has been estimated that over the past 30 years, droughts resulted in a total cost burden of €100 billion.

1.3. WATER CONSUMPTION IN EUROPE

In absolute terms, the total renewable freshwater resource in Europe is around 3 500 km^3/year. Twelve countries possess less than 4 000 m^3/capita/year while the northern countries and Bulgaria have the highest water resources per capita. Inflows from transboundary watersheds can provide a significant percentage of freshwater resources in some countries.

All economic sectors require water for their development and agriculture, industry, and energy production in particular cannot function without water. The most important uses of water, in terms of total water abstraction, are energy production (hydropower and cooling of power plants), agriculture, urban use (buildings and industry connected to the public water supply system) and industry in that order (see Figure 1:).

Figure 1: Water abstractions per sector for the period 1997-2005 (Eurostat, 2005)



Abstractions for different water uses exert pressure on the quantity of freshwater resources. Total water abstraction in Europe is about 353 km^3/year, meaning that about 10% of Europe's total freshwater is abstracted annually. Figure 2 presents the water exploitation index (WEI)[2] for different European countries. The WEI warning threshold can be 20%, which distinguishes a non-stressed region from a stressed one. Severe water stress can occur for WEI>40%, which indicates strong competition for water, but which does not necessarily trigger frequent water crises. Some experts think that 40% is too low a threshold, and that water resources can be used much more intensely (up to a 60%), while others believe that freshwater ecosystems cannot remain healthy if the waters in a river basin are abstracted intensely, i.e. WEI>40% (*Alcamo, 2000*).

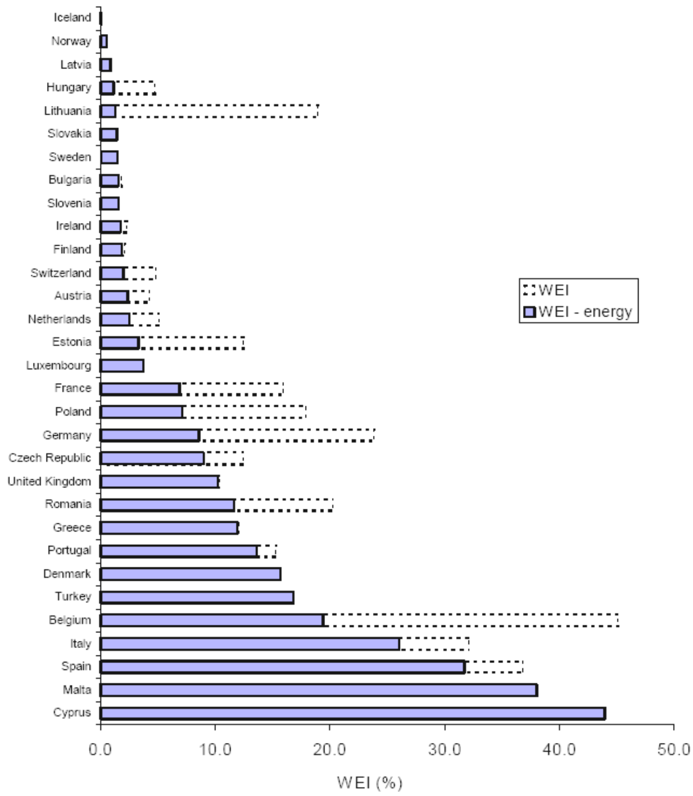
In Europe (including Norway, Iceland, Switzerland and Turkey), a total of 20 countries (50% of Europe's population) can be considered as non-stressed, lying mainly in central and northern Europe. Seven countries can be considered as having low water stress (32% of Europe's population). These include Romania, Belgium and Denmark and southern countries (Greece, Turkey and Portugal). Finally, there are four countries (Cyprus, Malta, Italy and Spain) which are considered to be water stressed (18% of Europe's population). Water stressed countries can face the problem of groundwater over-abstractions and the consequent water table depletion and salt-water intrusion in coastal aquifers (*Marcuello et al., 2003*).

[2] Water exploitation index (WEI) is the average annual total abstraction of freshwater divided by the long-term average freshwater resources of a country and indicates the pressure induced by water demand on the available water resources.

Southern European countries use the largest proportion of abstracted water for agriculture (80% in new MS[3], and 65% in Western countries) and irrigation is the most significant water use in agriculture, almost 100%.

Total water abstraction has decreased over the last decade in most regions of Europe with the exception of south Eastern Europe, where it has relatively stable, but low, and southern EU-15 where the rate of abstraction rose between 1992 and 1998, becoming somewhat stable thereafter (Figure 3).

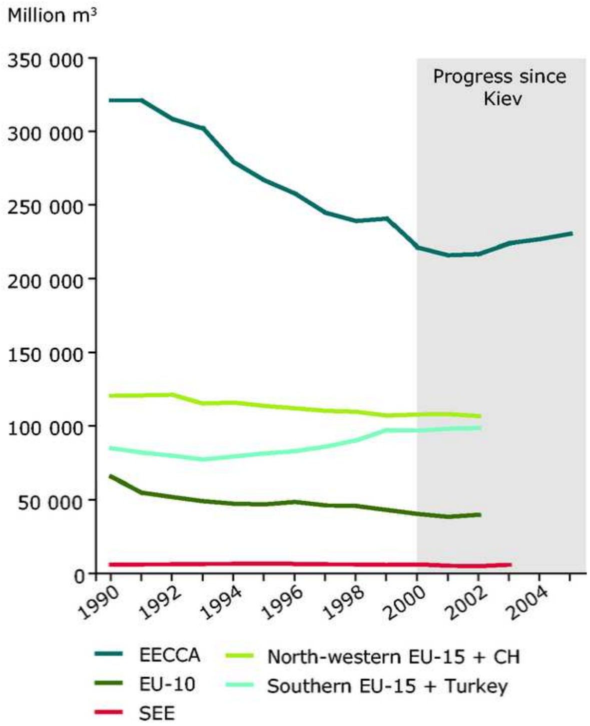
Figure 2: WEI across Europe (*Nixon et al., 2003*) *



* *Solid bar: WEI without water abstraction for energy cooling;*
Dotted bar: WEI based on total water abstraction.

[3] Please note that some the graphs on the following pages have been extracted from a report published in 2004 and AC refers to accession countries. However, most of them are now Member States and we regret for this conscious error.

Figure 3: Water abstraction trends in different regions of Europe (*European Environment Agency, 2007*)



1.4. POLICY ACTION IN THE EU

One of the aims of the sixth Environment Action Programme of the EU (2002-2012) is to provide products and services using fewer resources, such as water, and encouraging resource efficiency through sustainable consumption patterns. One of its objectives related to water is to ensure that rates of extraction from EU water resources are sustainable over the long-term. To achieve this objective, measures to improve the efficiency of water use in different economic sectors have to be implemented at national, regional, and local levels.

➢ **Communication on water scarcity and droughts**

In recognition of the acuteness of the water scarcity and drought challenges in Europe, on July 18th 2007, the European Commission (EC) adopted a Communication addressing the challenge of water scarcity and droughts in the EU. This Communication provides a fundamental and well-developed first set of policy options for future action, within the framework of EU water management principles, policies and objectives.

Although no new laws are proposed at this stage, the Commission aims to open a debate on the ways the EU can address water scarcity and droughts in an environment dominated by climate change by listing a number of recommendations.

Among various identified policy options, one of them suggests analysing the potential of water efficiency standards for Water-using Products (WuPs) at EU level. This option needs further assessment in terms of feasibility and implementation, and forms the subject of this study.

The first follow up report to the Communication was adopted in December 2008. This report aims to summarise the progress made with regard to the policy options identified in the previous Communication, and is accompanied by a work programme. The implementation of this work programme will be monitored and will be part of the review of the strategy for water scarcity and droughts mentioned in the Council Conclusions of 30th October 2007, which is planned for 2012.

- **Water Framework Directive (WFD)**

The WFD sets a framework for the comprehensive management of water resources in the European Community, within a common approach and with common objectives, principles and basic measures. It addresses inland surface waters, estuarine and coastal waters and groundwater. The fundamental objective of this Directive is to maintain "high status" of waters where it exists, preventing any deterioration in the existing status of waters, and achieving at least "good status" in relation to all waters by 2015. The WFD can help to address issues of water scarcity, through implementation of water management plans and associated programmes of measures. In particular, article 11 requires the implementation of a programme of measures taking into account water quantity issues and measures to promote an efficient and sustainable use of water. It also requires the implementation of a systematic control over the abstraction of fresh surface water and groundwater. Furthermore, article 9 and annex III require the recovery of the costs of water services, including environmental and resource costs, to be taken into account in accordance with the polluter pays principle. It requires MS to ensure, by 2010 at the latest, that water pricing policies provide adequate incentives for users to use water resources efficiently and that various economic sectors contribute to the recovery of the costs of water services, including those relating to the environment.

- **Water efficiency in Buildings**

To date there are no minimum standards for water consumption or water efficiency in buildings at the EU level. However, some relevant initiatives that affect water consumption in buildings are described below:

- The Council Directive 92/75/EEC on the indication of the consumption of energy and other resources by household appliances through labelling and standard product information aims to promote the use of more resource-efficient appliances. This Directive applies to many water-using appliances such as dishwashers, water heaters and hot-water storage appliances, dryers, and washing machines.
- Council Directive 89/106/EEC on construction, however, does not include requirements related to water management or water efficiency of appliances and systems.

➢ Ecodesign Directive

The Ecodesign Directive for energy-using products was adopted in 2005 (Directive 2005/32/EC). It establishes a framework under which manufacturers of energy-using products will, at the design stage, be obliged to reduce the energy consumption and other negative environmental impacts that occur throughout the product's life-cycle. The primary aim of this Directive is to reduce energy use, but it also enforces other environmental considerations including water use. Implementing measures are currently under consideration for several appliances like dishwashers and washing machines. Furthermore, within the recent Action Plans for Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP), it was proposed to extend the scope of this Directive. It will now be able to address the environmental impacts of some WuPs through Ecodesign[4].

➢ Common Agricultural Policy (CAP)

Agriculture is one of the most water consuming sectors in Europe. Agri-environment schemes were introduced into the EU agricultural policy during the late 1980s as an instrument to support specific farming practices which help to protect the environment and maintain the countryside. With the CAP reform in 1992, the implementation of agri-environment programmes became compulsory for MS in the framework of their rural development plans. The principle that farmers should comply with requirements for environmental protection as a condition for benefiting from market support was incorporated into the Agenda 2000 reform. The 2003 CAP reform maintained the nature of the agri-environment schemes as being obligatory for MS, whereas they remain optional for farmers. In particular, under rural development measures, the CAP provides support for investments that improve the state of irrigation infrastructures and allows farmers to shift to improved irrigation techniques (e.g. drop irrigation) that require the abstraction of lower volumes of water.

Agri-environment schemes cover commitments to reduce irrigation volumes and adopt improved irrigation techniques (*DG Agriculture (1) (2), 2008*). Furthermore, the 2003 CAP reform puts greater emphasis on cross-compliance, which became compulsory. In the framework of this reinforced cross-compliance, the 2003 reform demanded the respect of requirements arising from the implementation of the groundwater Directive. Nevertheless, according to the in-depth assessment on water scarcity and droughts carried out by the Commission, agri-environmental measures set-up during 2000-2006 only partially, and sometimes not at all, contributed to addressing water scarcity and drought issues. Very few MS have adopted specific agri-environmental measures aimed at addressing quantitative issues in the 2000-2006 programmes (*Flörke, 2004*).

The CAP reforms which began in 2003 contained a number of review clauses for the years 2007-2008. These are the basis of the so-called "Health Check of the CAP", which

[4] The Ecodesign Directive (recast) which covers energy-related products (such as water using products) has been adopted by the European Parliament on 24th April 2009.

aims at streamlining and modernising the CAP. One of the questions to be assessed within the context of the Health Check is how to confront new challenges, including water management[5]. For water management, the Commission is screening existing measures within Rural Development Plans, which will allow the identification of measures with the highest potential impact, and the eventual need to strengthen them further. An assessment of the impact of existing (and eventually new) relevant measures is also being carried out (*MEMO/07/476)*.

- **Energy policies**

There is a close link between water consumption and energy production and use. Most forms of energy production depend on the availability of water (e.g. the production of electricity at hydropower sites, cooling methods of thermal power plants, etc.). At the same time, water demand also influences energy consumption. For example, hot water use in households for showers and baths as well as for washing clothes and dishes is a major driver of household energy consumption (*DG Environment, 2008*). In spite of this well established link, it is observed that most of the recent energy policies (e.g. Directive 2005/89/EC on security of electricity supply, Directive 2006/32/EC on energy end-use efficiency and energy services, Directive 2003/30/EC on the promotion of the use of biofuels and other renewable fuels for transport, etc.) do not consider the current water situation, nor do they explore the interactions between water and energy production and consumption.

- **EU Eco-label**

The EU Eco-label scheme acts as the EU's voluntary labelling scheme for products and services, as laid down in the Regulation (EC) 1980/2000. It is now part of a wider approach on Integrated Product Policy (IPP), which seeks to minimise the environmental degradation caused by products by looking at all phases of a product's life-cycle and taking action where it is most effective. The Eco-label therefore serves as part of a variety of tools under the IPP that can be used to achieve this objective.

In terms of reducing the water consumption of WuP, this is only covered explicitly in some product groups, namely dishwashers and washing machines. It should be noted that the Eco-label for washing machines is no longer available. In fact it was never awarded to any washing machine, and, at present, only one dishwasher has been awarded the Eco-label. The Eco-label scheme also applies water-saving criteria for campsites and tourist accommodation services.

1.5. IMPROVING EFFICIENCY IN WATER USE

According to a study conducted for the EC *(Dworak et al., 2007),* there is a huge potential for water saving across Europe. This report shows that the sector that uses

[5] Communication from the Commission: "Preparing for the 'Health Check' of the CAP reform" (20/11/2007)

the most water is energy production, which represents 44% of the total water abstraction in Europe, followed by agriculture (24%), public water supply (17%), and industry (15%). The report analysed, for each of these sectors, the water saving potential and the technical measures that could contribute to meeting those water savings. The results suggest that:

- In the public water supply sector (including households, public sector, and small businesses), water savings of up to 50% could be achieved by reducing leakage in water supply networks, introducing water saving devices, and using more efficient household appliances.
- Regarding agriculture, the potential water savings from irrigation could amount to up to 43% of the current volume abstracted. For example, 30% saving is possible from changes in irrigation practices, up to 50% by using drought-resistant crops, and about 10% from the reuse of treated sewage effluent.
- In industry, the introduction of technical measures such as changes in processes leading to reduced water demand, higher recycling rates, and the use of rainwater, could lead to savings of 15% to 90% with a global estimate of 43% of current water abstraction.
- The tourism sector also has a high reduction potential in certain areas of Europe. This sector could reduce its consumption by a maximum of 80% to 90% through the application of technical measures such as the installation of water efficient appliances in guest rooms, cafeterias, kitchens, etc.

These results show significant possibilities for water saving by avoiding overexploitation, using non-conventional water abstraction, and promoting integrated water saving measures. The acuteness of the water scarcity and drought challenges in Europe boosts the need for new technologies and water management systems.

The results of this study suggest that water efficient appliances are one of the most important ways of conserving water while saving money. Increased water efficiency by the use of more water-efficient devices and alternative water sources is likely to be a core component of balancing water supply and demand in the future.

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2. STUDY OBJECTIVES AND METHODOLOGY

2.1. OBJECTIVES OF THE STUDY

This study aims to analyse the need for the introduction of water efficiency standards for water-using devices at the EU level and discusses the potential advantages and disadvantages of such an approach based on existing evidence in MS and beyond. The main objectives of the study are:

- To analyse existing water efficiency standards in Europe and other countries and identify their benefits and limitations.
- To analyse the need and feasibility of EU efficiency standards for water-using devices and their effectiveness, e.g. in the context of revised Ecodesign Directive (2005/32/EC) where its scope has been extended to energy-related products[6].

2.2. APPROACH AND METHODOLOGY

The general approach of this study was to analyse the potential for the introduction of water efficiency standards for WuPs at EU level and to illustrate the critical issues with the help of case studies.

The first step was to provide a general definition of a WuP, followed by the development of a list of WuPs for different sectors (buildings, industry, and agriculture), and the prioritisation of WuPs. In parallel, one important aspect of the study was the groundwork for the stakeholder consultation process (of industry, Member State representatives, and other relevant stakeholders). The purpose of the stakeholder consultation was to collect information on existing specific regulations or programmes at the national or sub-national levels within and outside Europe, and on the introduction of water efficiency requirements for WuPs. Furthermore, it aimed to fill in data gaps on water performance and the improvement potential of existing WuPs. This was achieved through a dedicated questionnaire and website. Key stakeholders and experts were also contacted to gather further information.

A mapping of existing regulation and other policy instruments (voluntary or mandatory) enabled the identification of issues related to policy implementation such as methodology, scope, and effectiveness.

Specific references were made to best practices and case studies at regional/local/site levels, e.g. existing methodologies and/or requirements that have been proven to be effective in improving the performance of WuPs.

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[6] Adopted by the European Parliament on 24th April 2009

The following sections present the key steps, and the approach and methodology adopted for each step.

2.2.1. DESK STUDY

In order to take into consideration the existing research on the subject, a desk study of existing relevant publications and internet sources was performed.

A significant body of literature exists on various issues related to water use in different sectors and by different products. The literature review focused on gathering the following information:

- Water use in different sectors;
- Water consumption of WuPs used in the building, agricultural, and industrial sectors;
- User behaviour and use patterns of WuPs;
- Water-saving potential for different WuPs and alternative designs/options; and
- Regulations or programmes at the national or sub-national levels which introduce water efficiency requirements.

The literature review helped the team define a preliminary scope for the study in terms of product categories and specific WuPs. However, the literature review revealed some challenges related to assessing the necessary data, as well as obtaining recent enough data on water consumption and the use of WuPs at the EU level. Nevertheless, for particular MS, information was available related to water consumption, user behaviour, and improvement potential in the water performance of WuPs. Wherever possible, the data that most accurately represents the EU and which takes into account the particularities of the MS was used.

2.2.2. STAKEHOLDER CONSULTATION

The information collected through the literature review was further completed and updated via the stakeholder consultation, targeting representatives of different MS, European and national associations for water supply and water and wastewater management, key experts, and research institutions.

➢ **Questionnaires**

A questionnaire was sent to 56 authorities in different MS to identify existing water efficiency requirements for the WuPs identified in the scope of the study. The questionnaire targeted the specific information needs identified during the literature review, to ensure that all information necessary for this study was collected. In particular, this questionnaire for MS aimed at gathering up-to-date information on the existing water efficiency standards of application in the MS; the development, implementation, and results of existing schemes and programmes introducing water efficiency requirements; and other water conservation programmes and initiatives (including economic instruments and general strategies) currently in place to promote water efficient products.

The questionnaire was further adapted and sent to 33 other stakeholders, including 21 European and national associations for water supply and management , 8 building and construction federations, and 4 research institutes across Europe.

In total, 7 responses were received (including those from 6 MS, i.e. Latvia, Estonia, Germany, Ireland, Sweden, and the United Kingdom).

- **Website**

A dedicated website hosting this study was created (www.waterefficiency.eu). An online version of the questionnaire was also made available on the website. In the future, the final report of the present study could be made available on the website for disseminating it to a wider audience.

- **Interviews**

Interviews were conducted (via phone or e-mail) with 12 experts in different MS and countries outside Europe. The objective of these interviews was to further complete the information collected through the questionnaire and desk study and also to gain further insight into the implementation and results of different programmes and schemes which introduce water efficiency requirements.

2.2.3. INFORMATION PROCESSING AND ANALYSIS

The first task of this study consisted of defining the scope in terms of sectors for which WuPs will be analysed. A preliminary list of priority WuPs was defined on the basis of their current water use efficiency, market share and trends, and potential for efficiency improvement. These parameters were also used for defining more precisely the scope of the study and to identify products which may fall outside the scope.

Major national, European and international standards and programmes, as well as other initiatives which could be potentially relevant to the study, were also identified through an extensive literature review.

Once standards were identified for the different product groups, comparative tables summarising the collected information were prepared to facilitate the identification of synergies and inconsistencies. The results of questionnaires and interviews with experts provided additional information on instruments used at national and sub-national levels within and outside Europe.

Based on the information gathered through the desk study and stakeholder consultation, the effectiveness and gaps and limitations of existing schemes and instruments were assessed. Some real-life case-studies covering examples of existing instruments and programmes were used to highlight these aspects. In total 5 case studies, 3 in Europe and 2 outside Europe were prepared.

In the next step, the necessity and feasibility of developing and introducing EU level water efficiency requirements for WuPs was analysed. In particular, the analysis took into consideration whether introducing EU standards will deliver further benefits compared to the current situation and identified potential social, economic, and environmental impacts on stakeholders (manufacturers, consumers, Member States, etc.). To this end, the gaps identified earlier regarding the insufficient geographical coverage of relevant standards across Europe, incomplete scope, or insufficient effectiveness of water performance requirements were duly considered. Based on this analysis, potential advantages (and possible barriers) of introducing different policy options related to water efficiency standards for WuPs within EU were assessed.

For the different WuPs that were identified and considered within the scope of the study, and using the information collected previously, priority categories that should be addressed in Europe (i.e. for Community action in the context of the current study) were identified based on their contribution to total water consumption in Europe, their potential for improvement, and market trends.

2.3. KEY DEFINITIONS

Following are key definitions that are used throughout the study.

2.3.1. WATER-USING PRODUCT

For the purposes of this study, a WuP is defined as a product that uses water to fulfil its intended basic function. It is assumed that after being used by the specific device or equipment, water becomes wastewater and does not directly return to the water source from where it was abstracted.

2.3.2. WATER EFFICIENCY

Water efficiency is the long-term ethic of conserving water resources, which include aspects such as new innovative technologies, but also changes in usage patterns of the WuP and behaviours that could reduce water consumption. According to a definition of water-efficiency, it can be defined as:

1. The accomplishment of a function, task, process, or result with the minimal amount of water feasible;
2. An indicator of the relationship between the amount of water required for a particular purpose and the amount of water used or delivered. (Vickers, 2002)

Further, it is important to note the difference between water conservation and water efficiency, although the two are often used interchangeably. Water efficiency differs from water conservation in that it focuses on reducing water wastage. A proposition is that the key for efficiency is reducing water wastage, not restricting its use. It also emphasises the influence consumers can have in water efficiency by making small behavioural changes to reduce water wastage and by choosing more water efficient products. These are things that fall under the definition of water efficiency, as their purpose is to obtain the desired result or level of service with the least necessary water *(Vickers, 2002)*.

2.3.3. BUILDING, AGRICULTURE, AND INDUSTRY SECTORS

For the purposes of this study, the term "building sector" refers to WuPs found in both residential and commercial infrastructures (domestic buildings: residential houses, apartments, etc., and commercial buildings: offices, schools, restaurants, hospitals, airports, etc.), in both urban and rural environments.

WuPs in the industry sector refer to the equipment used for production, processing, cleaning, cooling, and/or heating in different industrial activities.

For the agriculture sector, WuPs mainly refer to irrigation systems.

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3. PRODUCT SCOPE AND CLASSIFICATION

The main objective of this chapter is to develop an inventory of WuPs, and define their scope in order to prioritise them for possible policy development, e.g. products which represent significant water consumption and have significant water saving potential.

The following three sections present respectively information on each of the three identified sectors where WuPs are principally found: buildings (household and commercial), industry, and agricultural sectors. Based on the collected information through in-depth analysis of the literature review, a preliminary scope of WuPs for each of these sectors was identified for further analysis in the study. For each product category, information on the water consumption, improvement potential, and use patterns has also been summarised.

Finally, each sector has a sub-section on water performance that aims to identify relevant criteria for measuring the efficiency of different WuPs and to identify EU relevant ranges of use for different WuPs. Performance assessment in terms of *efficiency* inevitably involves measuring the volumetric water use, usually using a water meter, of the WuPs within a specific context, e.g. residential, commercial, etc. Variations in the volume of water used may be explained by the type of technology used, but can also be explained by other variables, often referred to *demand variables*. Demand variables might include the weather, i.e. temperature or rainfall, the frequency of use, the type of users, and the WuP's effectiveness in performing its function, etc.

Each subsection of the three different sectors is structured as follows[7]:

- Outlook of water use in the sector
- Scope definition of products
- Category definition
- Water performance assessment

The products that will be discussed hereafter are based on this information and are categorised based on the type of WuP and the sector (i.e. used in a residential or commercial setting, or for industrial, or agricultural purposes).

➢ **Data limitations in this study**

It should be noted that some data appears to be lacking for some of the WuPs investigated. While a large amount of data was available for household WuPs, less information has been found for commercial WuPs. The main reason for this is that data related to household WuPs has in some cases been integrated with data for their

[7] With the exception of the agricultural sector which after an initial scoping study, has not been dealt with in the same detail as the buildings and industrial sectors.

commercial counterparts (e.g. household vs. commercial toilets). Moreover, a large amount of performance data available for commercial WuPs was obtained from countries outside of Europe such as the US and Australia. Representative performance data for commercial clothes and dishwashers was also difficult to identify. Data gathering for industrial WuPs has proven to be a challenge as few studies have focused on water consumption in this sector. Large data gaps are evident in some product areas (such as cooling and steam generating equipment). However, generic cleaning products do appear to have more data provided.

3.1. WATER USE IN BUILDINGS

3.1.1. OUTLOOK OF WATER USE IN BUILDINGS

It is important to note that water use in buildings varies widely across Europe. In the case of households, water is mostly derived from a public water supply system and the technical performances of different supply systems can vary widely among different MS, because of varying leakage rates. Water use variation also depends on the water source and demographics, e.g. household water consumption for different activities will not be the same for United Kingdom and Spain, as living conditions, water supply systems, and use differ a lot between these two MS. This suggests that “household” water use statistics should be interpreted with care (*Dworak et al., 2007*).

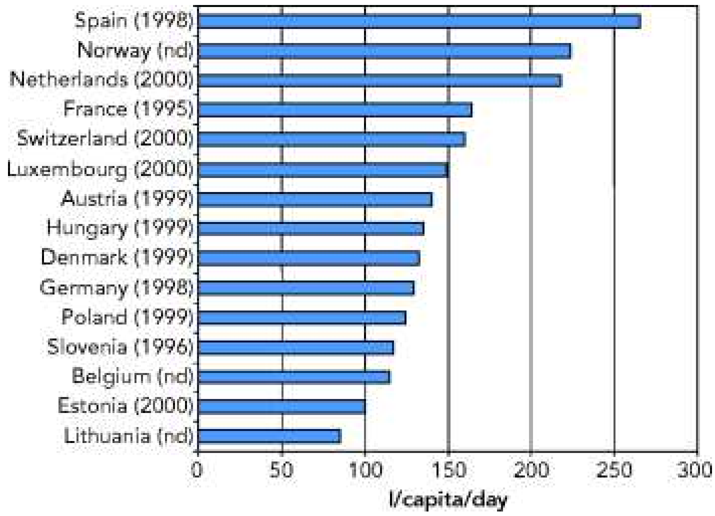
3.1.1.1 Water use in residential buildings

Water use in residential buildings can be attributed to various household activities. According to a report of the Office of Community and Economic Development (OECD) (*OECD, 2002*), approximately 35 to 40% of household water is used for personal hygiene (shower and bath), 20 to 30% for toilet flushing, and 10 to 20% for washing laundry[10] in OECD countries.

As shown in Figure 4 below, the highest per capita water consumption is in Spain followed by Norway, Netherlands, and France. Baltic countries and Belgium have the lowest household water consumption per capita (*Lallana, 2003*).

[10] Similar figures were also given by Waterwise, a British NGO focused on decreasing water consumption and promoting water efficient products.

Figure 4: Household water consumption (Lallana, 2003)



For measuring water consumption in residential buildings, water consumption *per* household *per* day (*l/hh/d*) provides only limited information on water efficiency in residential buildings. Dividing this value by the number of occupants, i.e. litres *per* capita *per* day (*l/c/d*), provides a better indication of efficiency. Table 1 provides *per capita* water demand in households for Western, Southern and Eastern European countries (for different MS for which relevant data and studies have been identified, and covering a variety of climatic and economic conditions in Europe). Although outdoor water use can be expected to be higher in Southern Europe due to the warmer climate, the data in Table 1 does not provide immediate evidence of this. Data from Cyprus and the comments about a peak 3 month period in demand in England and Italy, however, show that higher outdoor water use only increases significantly during the summer months, which is not revealed in the average annual water consumption volumes.

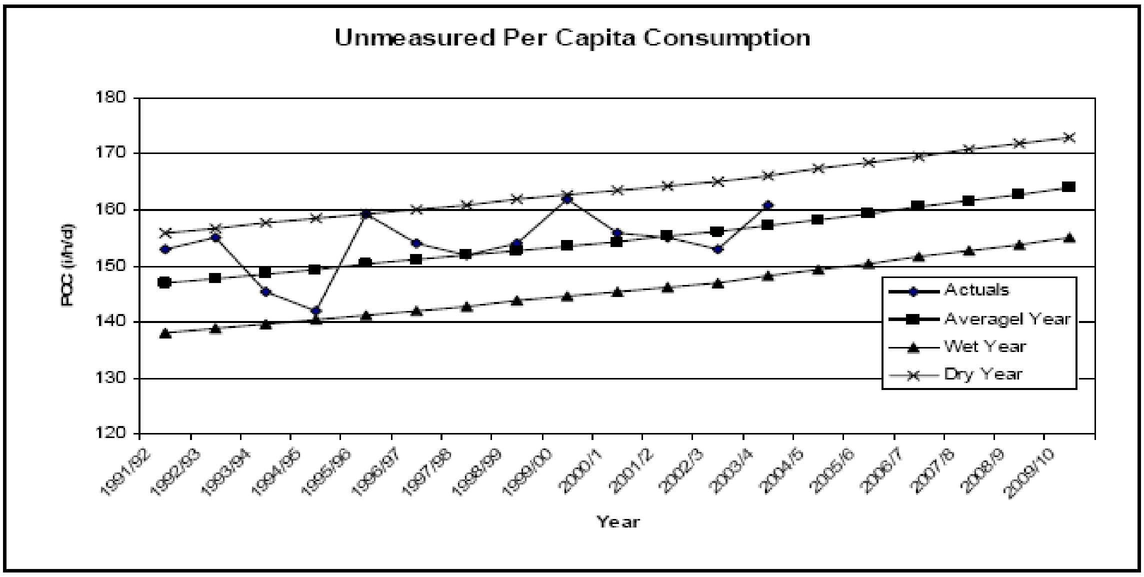
Table 1: Household water consumption in countries in Western, Southern and Eastern European countries

Country	Region	Average household consumption (l/c/d)	Range (l/c/d)	Data source	Comments
Cyprus	all areas	174	107 - 466	*Pashardes et al., 2001*	-
Bulgaria	Sofia	133	105 - 378	*Voda, 2005*	individual boiler supplied hot water
Bulgaria	Sofia	186	106 - 378	*Voda, 2005*	centrally supplied hot water
Poland	Bytom	123	-	*Kloss-Trebaczkiewicz et al., 2001*	decreased from 195 l/c/d in 1990
Poland	Katowice	164	-	*Kloss-Trebaczkiewicz et al., 2001*	decreased from 234 l/c/d in 1991

Country	Region	Average household consumption (l/c/d)	Range (l/c/d)	Data source	Comments
Poland	Sosnowiec	178	-	*Kloss-Trebaczkiewicz et al., 2001*	decreased from 365 l/c/d in 1992
Portugal	Guadiana	210	-	*Water Strategy Man, 2003*	-
Portugal	Algarve	184	-	*Water Strategy Man, 2003*	-
England	Portsmouth	153	74 - 252	*Portsmouth Water, 2005*	peak 3 month period 177-317 l/c/d
Italy	Sardinia	175	-	*EURISLES, 2002*	peak 3 month period 235-315 l/c/d

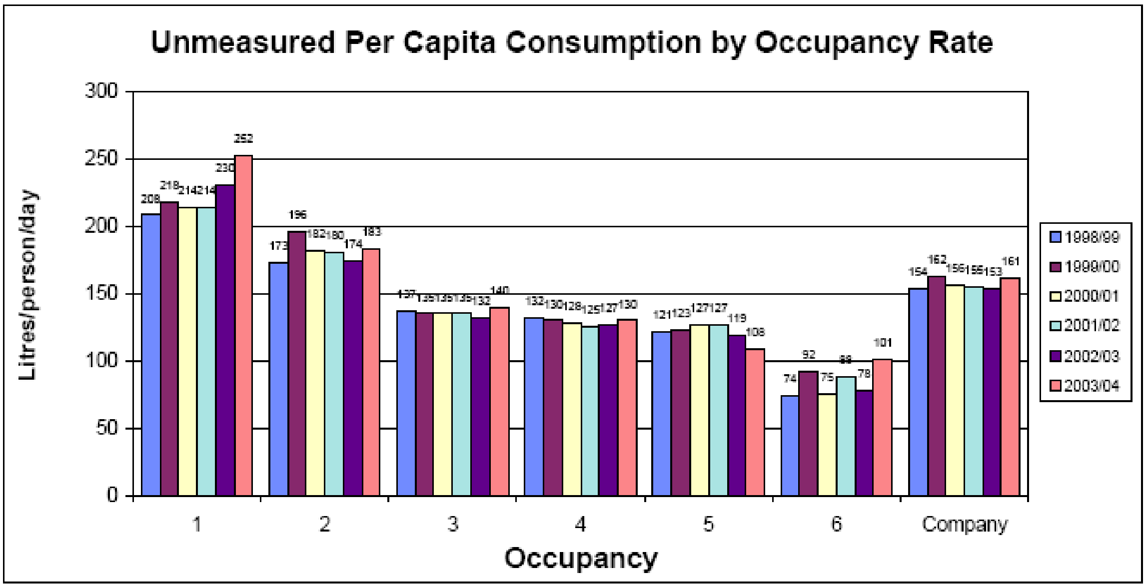
Portsmouth Water in Southern England has run a comprehensive household water demand monitoring database since 1991. Since the Company has no long-term storage, its critical period for balancing supplies with demand is during summer peaks. Therefore, it needs to be able to forecast peak demands in order to ensure it has sufficient resources for the future. In an attempt to measure the climatic effects upon household consumption, the Company has set up a 'Fixed Measured Property Database' of 1 500 properties from whom occupation data has been collected (*Portsmouth Water, 2005*). In this database, *per Capita Consumption* (*PCC*) in households increased from 153 l/c/d in 2002/03 to 161 l/c/d in 2003/04. This is above the average forecast line and is consistent with the warm summer conditions experienced during the summer of 2003 (see Figure 5).

Figure 5: Data from 1500 households in Portsmouth, England reveals an upward trend in PCC (*Portsmouth Water, 2005*)



The overall upward trend is believed to be due to the declining occupancy rate which automatically results in higher PCC. Single person households use 70% more water per person than households with four persons (see Figure 6). The UK Environment Agency has suggested that a further cause of the increasing per capita demand is the increasing use of water intensive white goods such as dishwashers and washing machines, and also water-intensive (power) showers.

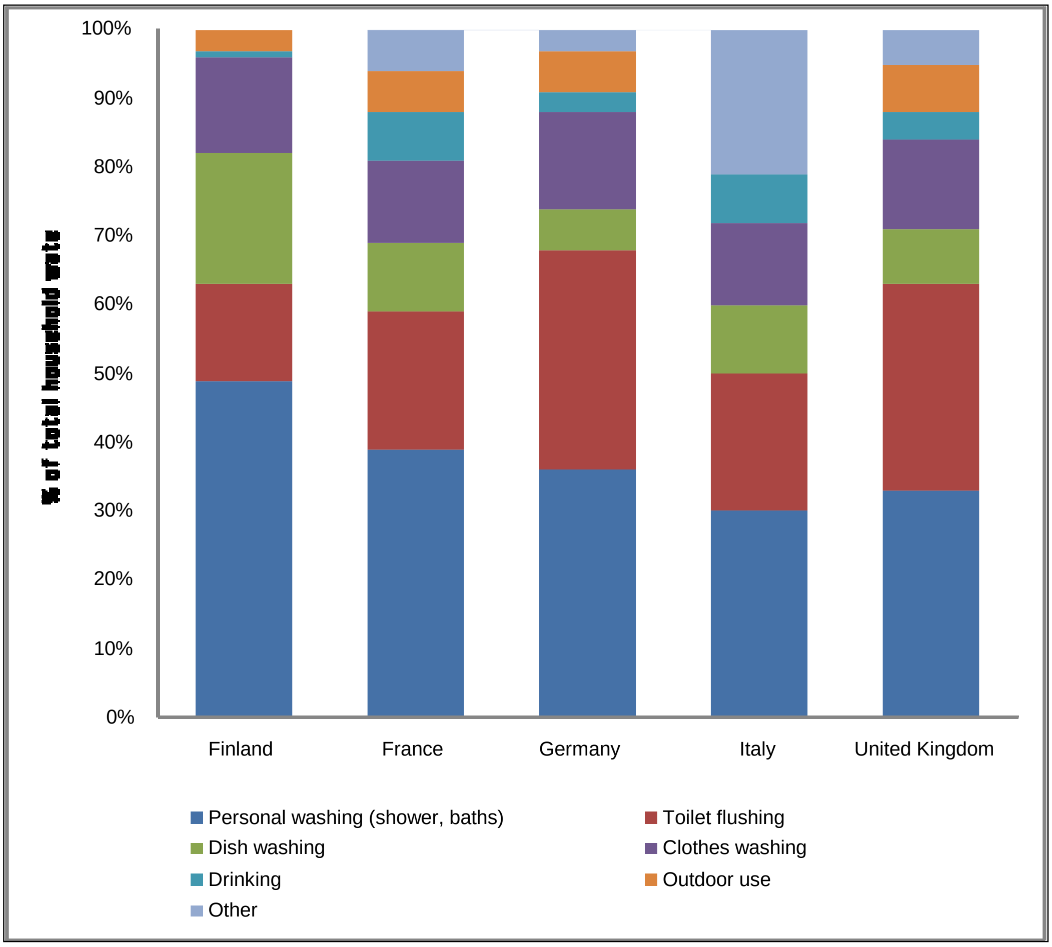
Figure 6: Single person households use as much as 70% more water than those in four bedroom households (*Portsmouth Water, 2005*)



The factors that influence *per capita* household water demand in residential buildings in the Portsmouth Water example, such as different numbers of occupants, show changing trends in residential buildings in the United Kingdom, and are being repeated across much of the Western Europe. On the other hand, evidence from Eastern Europe (*Kloss-Trebaczkiewicz et al., 2000; Aquastress, 2006*) indicates that household water consumption has decreased in recent years, due to higher efficiency in plumbing networks and buildings.

Figure 7 shows the breakdown of the water consumption for WuPs in several MS for which data was identified and covering different climatic and economic conditions in Europe. This data indicates that the majority of water use in residential buildings can be attributed to the following WuPs: toilets, personal hygiene (showers and baths), washing machines, and dishwashers. The figure is based on the most comprehensive data found available for MS based on our literature research.

Figure 7: Household water use in some MS[11]



Drivers for water use in households

Economic growth and increased population growth are the main drivers for water use and demand. These factors have also led to increased urbanisation and higher living standards, which are also major drivers in the increase of water use in buildings in the past century. Table 2 shows some of these drivers in further detail.

[11] Figure based on following data sources:
United Kingdom: Waterwise. Reducing water wastage in the UK. 13 Mar. 2009 <http://www.waterwise.org.uk>
France: Centre d'information sur l'eau. Les consommations à la maison. 21 Feb. 2009 < http://www.cieau.com>
Germany: J Schleich, and T Hillenbrand. Fraunhofer, ISI. Determinants of Residential Water Demand in Germany. Working Paper Sustainability and Innovation, No. S3/2007 (2007).
Italy: Sorella Acqua. Acqua Quotidiana, 2003. 6 Mar. 2009 <http://www.buonpernoi.it/acqua>
Finland: R P Rajala, And T S Katko. "Household water consumption and demand management in Finland." Urban Water Journal, Vol. 1, No. 1(2004): 17–26

Table 2: Main drivers for household water consumption and their impact on behaviour and water consumption (*OECD, 2002*)

Drivers	Household behaviour	Effect on water consumption
Population growth		+
Economic growth (GDP)	Larger percentage of households has access to water supply networks. Investment in improving systems (leakage reduction).	+
Per capita disposable income (together with environmental awareness or economic incentives)	More water appliances and increased use: WC, shower, bath, washing machine, swimming pool, garden and lawn care. Purchases of more water efficient technologies and appliances.	+ -
Changes in Lifestyles (together with environmental awareness or economic incentives)	Rising "comfort" levels: more frequent use of showers, baths, washing machines; higher water temperatures Water conservation and efficiency practices	+ -
Technological innovation	Water saving appliances such as showerheads, 6l WC, more efficient washing machines.	-
Improved Tariff structuring (Fees, taxes, metering)	Greater awareness of the "cost" of water	-
Environmental information and Awareness	Careful use of water.	-

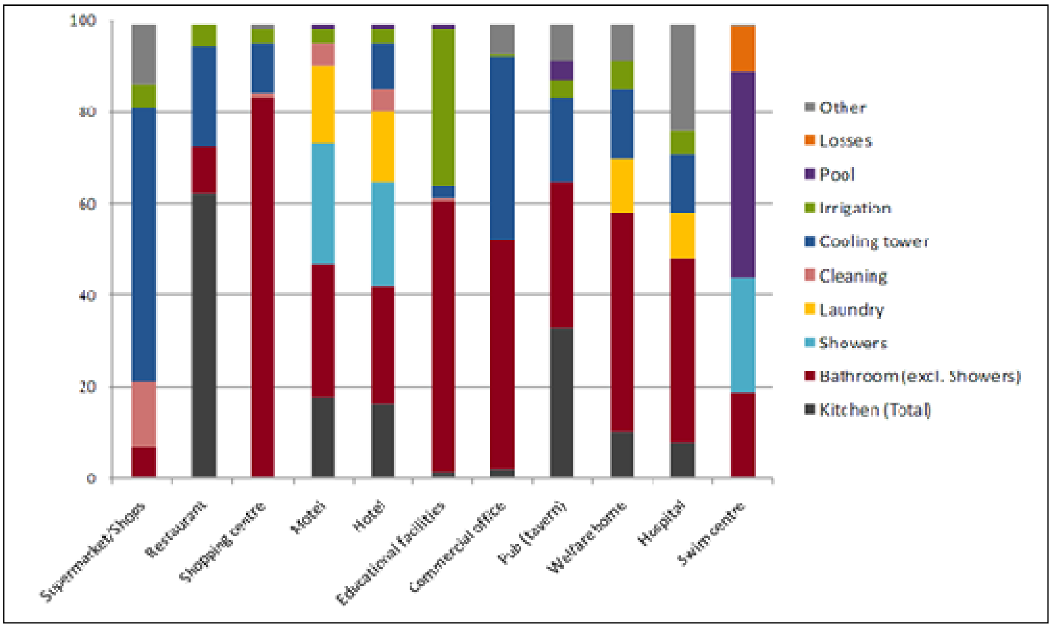
At higher levels of gross domestic product (GDP), more households are connected to water networks and to sewage systems for water treatment. On the other hand, higher household income is also linked to greater water consumption and ownership and capacity of water appliances (e.g. showers, toilets, water heaters, dishwashers, washing machines, sprinklers, swimming pools) (*OECD, 2002*). However, in the long term, higher household incomes mean that more consumers can afford water-efficient appliances. In order for this to occur, however, there must be some external and internal incentives that promote water savings, such as environmental pressure, changes in regulations and markets, environmental awareness, increasing water prices, and/or accessibility of water saving technology, etc. Chapter 4 explores this aspect in further detail.

3.1.1.2 Water use in commercial buildings

Water in the commercial buildings sector (non-industry and non-agriculture) is used for different purposes depending on the principal activities and use of the building, e.g. offices, hospitals, hospitality sector, restaurants, retailers, leisure and community centres, schools and universities, and small businesses.

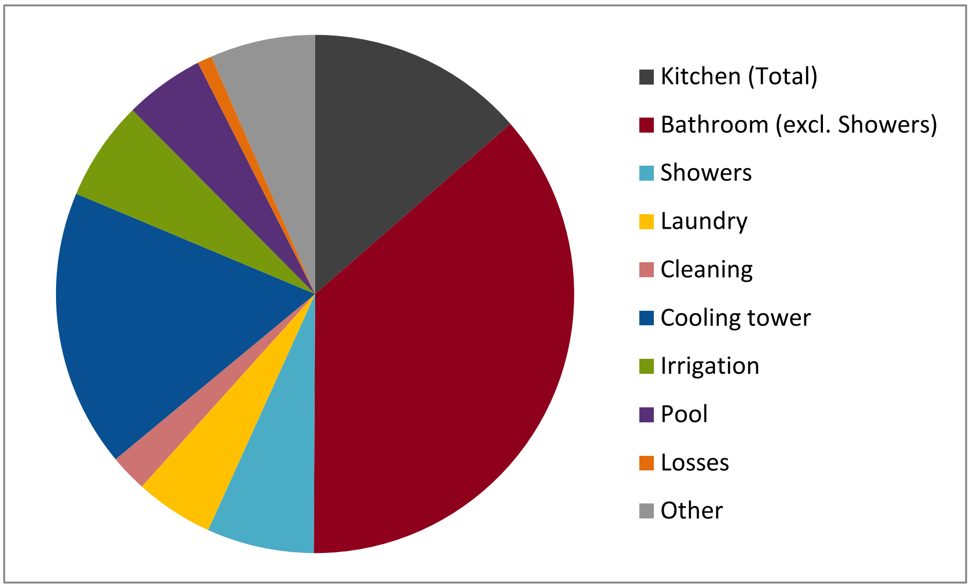
Unlike household water consumption, the distribution of different WuPs, and consequently the pattern of water consumption, can vary greatly depending on the function of each commercial building (*Department of the Environment and Heritage, AU, 2006*). Although Figure 8 refers to water use per product type in Australian commercial buildings, it illustrates wide variations across different types of commercial buildings and also provides an overview of different types of WuPs used in the commercial sector.

Figure 8: Average water use per product type in different commercial settings (in %)



Supermarkets and commercial offices are good examples to illustrate water-use disparities in commercial buildings. Supermarkets rely heavily on cooling towers for refrigeration and air conditioning, and thus represent the major water needs of this sector. Although office buildings also rely heavily on cooling towers, water consumption in restrooms contributes to a greater proportion in this type of building. Figure 9 below shows the total average water consumption per product type across all commercial sectors. It is clear that WuPs used for sanitary purposes (excluding showers, in the kitchen (e.g. dishwashers, ice machines, etc), and cooling towers are the highest in terms of percentage water consumption.

Figure 9: Average water use per product type in commercial buildings (%)



The results in Figure 8 and Figure 9 suggest that it is difficult to consider the total consumption (in litres) of a product across the entire commercial sector.

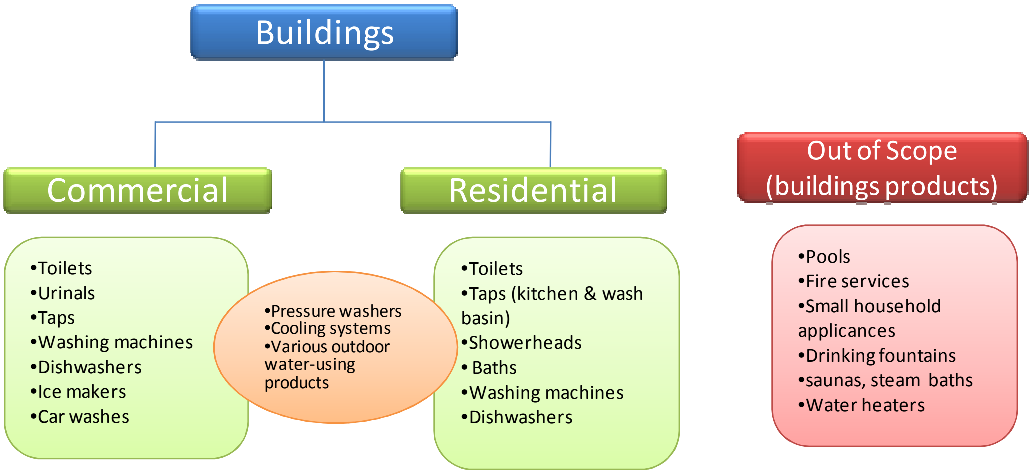
3.1.2. Scope definition

In residential buildings, the most water-intensive activities are toilet flushing, personal hygiene, and clothes washing. These are also the most promising areas for reducing water consumption and should be the focus of further policy initiatives to maximise water savings in these activities and to seek the most effective tools to promote sustainable water use at the residential buildings. In designing policy it is therefore important to focus attention on the main drivers of household water consumption (*OECD, 2002)*.

Results of the literature review have revealed that some of the most significant and widely used WuPs in residential buildings include toilets, showerheads, bath and kitchen taps, clothes washing machines, dishwashers, and outdoor gardening equipment.

Many of the WuPs found in residential buildings are also found in commercial buildings. However, most of these products are designed distinctly for either residential or commercial use because of the different water needs and use frequencies (e.g. urinals are usually found only in commercial settings). Figure 10puts the main WuPs found in residential and commercial buildings in categories and defines the scope criteria of this study. Nevertheless, there exist certain WuPs that are found in both residential and commercial buildings which represent similar characteristics in terms of usage and water consumption (see overlapping products included in Figure 10).

Figure 10: WuPs used in residential and commercial buildings



Explanations for excluding certain WuPs from the scope of the study are provided in Table 3 below.

Table 3: Explanations for excluding certain WuPs from the scope of this study

Product	Explanation for the exclusion
Pools	Pools principally function as water storage products, and less as a "water using" product
Fire fighting Services	Well-being and safety of citizens is a higher priority than water saving potential of the products used in fire fighting services
Small household appliances (coffee machines, steam cookers, rice cookers, etc.)	Many small household appliances are being covered by the Ecodesign Directive, which also addresses water consumption
Drinking fountains	Drinking fountains function very similarly to taps, which are covered under this study, and thus are not specifically addressed. In addition, little information on market data and water consumption was found
Steam and sauna baths	Steam and sauna baths and related products are left out of scope because the use of these products is limited to specific geographic region
Water heaters	Water heaters are not included within the scope of this study because they are covered under the Ecodesign Directive, which also addresses water consumption

3.1.3. Categories definition

This section aims to further analyse the WuPs indentified in the buildings sector (see Figure 10). A description and context of use of the standard product is given, as well as factors affecting water consumption, potential for improved water efficiency, and market trends. This section first addresses WuPs found in residential buildings, followed by WuPs used in commercial buildings. It should be noted that WuPs that are found in residential and commercial buildings are quite similar, with the major difference seen in use patterns. Therefore, for commercial WuPs references are often made to the descriptions of the corresponding residential WuP.

3.1.3.1 Residential toilets

Definition: Toilets dispose of human waste by using water to flush it through a drainpipe to another location. Water-activated toilets (WC) consist of two main components: the pan and the cistern. WC flushing mechanisms can be divided into those with valves and those that are valve-less, with the former sub-divided into single-flush and dual-flush or (for domestic installations) into drop-valves and flap-valves.

- **Description of the standard toilet in the EU**

The most commonly used residential toilets in the EU are single flush toilets. A standard single flush toilet work as follows. A pre-set amount of water is stored in the upper tank. When needed, the user presses a handle that raises a stopper at the tank bottom that opens and allows the water to run by gravity from the upper tank to the bowl that fills and, through siphon action, flows down and out carrying the contents into the drain. Conventional toilets can be installed almost anywhere there is running water.

In a conventional toilet cistern with traditional ball float (inlet) valves and flushing (outlet) valves, there is a great deal of water wasted during the flushing cycle. The majority of wastage occurs because the inlet valve opens as soon as the toilet is flushed and therefore more water ends up being flushed than is originally held in the cistern (*St John's Innovation Centre, 2008*).

Single flush toilets are based on either on 9, 7.5, or 6 litres cisterns. This is due to the fact that some existing houses will have larger volumes. Others will have been renovated to incorporate lower volume flushes and many recent new homes will have 6-litre cisterns.

- **Factors affecting water consumption**

Of all WuPs used in residences, toilets (also referred to as WCs) are one of the most important products in terms of frequency of use and water consumption. As explained earlier, toilets represent about 30% of the total water use in a residence. The main factor affecting the amount of water used per household for toilets is flush volume. The actual flush volumes of installed WCs depend on two factors: the installation and performance of toilets and user behaviour. An effective flush volume is the volume of water needed to clear the toilet pan and transport solids far enough to avoid blocking the drain. Other factors include whether the WC is leaking, and the frequency of use, usually determined by the number of occupants. See sub-section 3.1.4.1 pg. 83 on the water assessment for toilets for estimates on their water consumption.

- **Potential for improved water efficiency**

Research has uncovered several additional types of water efficient toilet systems that are currently available on the market which can be seen in Table 4 (*Ornelas, 2009*). In particular, dual-flush toilets represent an interesting case for improved water efficiency in residential buildings because these toilets not only provide higher water performance compared to the standard toilet but are widely used in the Europe.

Dual flush toilets present significant water savings because they have a split flush button giving the user the choice of pressing a small button or a large button depending on how much water is required to clear the toilet bowl. These toilets typically operate with a handle that can move up or down, or a two-button system. One direction or button will activate the lower flow flush, while the other will activate the higher flow flush. Dual flush toilets are being voluntarily installed as the norm on most modern commercial buildings demonstrating that the water saving advantages of dual flush are accepted in the market place. They act as water saving mechanisms as only one out of five visits to the WC warrants a full flush (*Grant et al., 1999*).

Table 4 shows the current available water efficient toilet systems and shows certain toilet retrofit devices can also be used on existing products to save water without replacing it. Retrofit means adapting or replacing an older water-using fixture or appliance with one of the many water-efficient devices now on the market. While these solutions cost more, they also save the most water and money. Retrofitting offers considerable water saving potential in the home and business. In the case of toilets, **water retention devices, water displacement devices**, and **alternate flushing devices** can be adapted in the tank of an existing toilet to reduce the amount of water used in a flush cycle.

Table 4: Water efficient toilet systems and toilet retrofit devices

Product	Description (advantages and tradeoffs)
Gravity Fed Single-Flush Toilets 	They operate the same way as any standard toilet; however, they use less total capacity per flush.
Pressure Assist Toilets 	These toilets use either water line pressure or a device in the tank to create additional force from air pressure to flush the toilet. The device in the tank could either be a storage device with compressed air that would require replacement or a tank that creates pressure when the tank is being filled. Some pressure assist systems move a greater volume of water at a significantly lesser volume of sound.
Power Assist Toilets 	Power assist toilets operate using a pump to force water down at a higher velocity than gravity toilets. Power assist toilets require a 120-V power source to operate the small fractional horsepower pump. Dual-flush models are also available.
Dual-Flush Toilets 	These types of toilets have a split flush button that determines how much water is required to clear the toilet bowl.
Cistern displacement devices 	The water displacement devices familiar to most people are the plastic bags or bottles filled with water which are suspended inside the toilet tank. These devices displace several litres of water, saving an equivalent amount during each flush. Their chief disadvantage is that they don't save as much water as other devices and, is only beneficial if the existing full flush is excessive.
Alternative flushing devices 	Dual flush retrofit devices are installed in the toilet's water tank and it will enable you to have the option of a regular flush or a half flush. However, a disadvantage would be the potential for double flushing. A variable flush system is fitted onto the siphon in the cistern and allows control of the duration of the flush. By putting the user in control of the amount of water used, it could potentially save up to half the water used in the average flush.
Water retention devices 	The most common water retention device available is the toilet dam. Their main attraction is their low cost and the fact that they are easy to distribute and install for example, as part of a wider municipally-sponsored retrofit program. Their main disadvantage is that they tend to leak over time by slipping out of adjustment and can slip free and interfere with the moving parts inside the toilet tank, if not routinely checked.

Waterless toilets

Most waterless toilets come in the form of composting or incinerator toilets and are completely waterless. These toilets are rare in cities and suburbs because of the difficulty in securing appropriate building permits, but they are more common in rural areas. Composting toilets convert human waste into compost, which can be utilised as fertiliser once it has been treated. Waterless composting toilets (also known as humus closets or biological toilets) are waterless systems that are either continuous or batch. Continuous systems contain one chamber, whilst the batch systems contain several bins, with rotation occurring after each bin is filled. In both systems, chambers or bins are installed below floor level. It should be noted that these products are expensive and require stringent maintenance requirements. The factors of water content, temperature, air flow patterns, pH, toilet usage rate, surface area of compost and oxygen penetration depth, all influence the rate and effectiveness of the biological breakdown of the waste materials (*Central Coast Council, 2007*). Because waterless toilets do not consume any water for operation, it could represent significant water savings in the buildings sector. However, as has already been noted, these products are not currently widely used due to high prices, and complications involving installations and maintenance requirements. According to one source (*EPA, 1999*), for a year-round home of two adults and two children, the cost for a composting toilet system could range anywhere between $1 200 and $6 000, depending on the system. Current waterless toilets are not a simple direct replacement for the WC. For rural and suburban eco-houses and remote toilet blocks they can represent a best available technology but their widespread use is not considered likely in the EU at present (*Grant, 2002*).

Some waterless toilets can also be found in commercial buildings.

Market trends

Toilets offer great potential for decreasing residential water consumption. However, this will depend upon the availability of more water efficient WCs. The replacement cycle for WCs is estimated to be around 15 years and they tend to be replaced for reasons of style, colour etc. rather than failure (except in the case of breakages). Therefore, the current limited availability of styles for very low flush volume WCs will act as a barrier to the selection of these units rather than a less efficient design. However, pricing in the longer term should not be a barrier to uptake as currently available water-efficient WCs tend not to be priced higher than the market average. In the United Kingdom, the long-term (10-year) decline in the price of base-line (inefficient) water-using equipment is expected to be 2.45%. Reductions in the price of water-efficient equipment of between 5% and 15% are expected, but it is recognised that the price of efficient products is never likely to be lower than the price of inefficient products. Current example prices for WCs are approximately €185 for a 6/4-litre dual-flush toilet, €312 for a 4.5-litre toilet, but surprisingly only €135 for a 4.5/3-litre dual-flush2 toilet (*Market Transformation Programme (1), 2008*).

In general, fitting a device to retrofit the existing cistern to dual flush or fitting a new cistern to convert to dual-flush are felt to be more permanent and satisfactory than fitting cistern-displacement devices. Replacement of older cisterns, e.g. high-level cisterns, can lead to the highest savings, but high costs and health and safety restrictions mean that these are less favourable for plumbers to change. Similarly, close-coupled WCs and slim line models impose restrictions.

Some PRODCOM (PRODucts of the European COMmunity) data (see sub-section 3.1.3.17, page 77) has been identified, which can be used to get an overall picture of the market for toilets in the EU.

3.1.3.2 Residential taps (Kitchen and washbasin taps)

Definition: A tap is defined as a 'small diameter manually operated valve from which water is drawn' (BS 61006). Internal taps include both kitchen and wash bin taps.

- **Description of standard taps in the EU**

In Europe, taps and mixers (also referred to as 'brassware') control the water flow in bathroom wash basins, kitchen faucets, and baths. A tap is a valve for controlling the release of water from a hot or cold supply pipe. The conventional pillar tap is the most commonly used type of tap used in kitchens and washbasins. Pillar taps are traditional separate hot and cold taps which do not blend the water. Today most taps are supplied in brass or metal alloy with a chrome plated finish.

Mixer taps are also common but less so than pillar taps. Mixers taps are a form of combination tap assembly, whereby there are separate hot and cold inputs, which have a single output. The inputs can be adjusted to give the required temperature and flow, so as to discharge hot, cold or mixed hot and cold water.

- **Factors affecting water consumption**

Kitchen and bathroom taps can account for more than 15% of indoor residential water use (*Market Transformation Programme (2), 2008*). Both kitchen and bathroom wash basin taps can be used for various purposes (e.g. washing, cleaning and rinsing, or for vessel filling). The frequency of use of washbasin and kitchen taps per household is related to the occupancy of the residence. For example, the number of internal tap events per person reduces as the occupancy of the household increases. Other factors that influence the frequency of tap use is whether a household owns, and uses, a dishwasher. According to findings of the United Kingdom's Market Transformation Programme (MTP), in homes where a dishwasher is installed it is estimated that kitchen taps are used on average just over 17 times a day per household. In homes where no dishwasher is used, kitchen taps are used on average just over 24 times a day per household. This is equivalent to 55% of all tap uses across all homes (*Market*

Transformation Programme, 2008). Thus, it can be assumed that in homes where no dishwasher is installed, kitchen taps are used more than if there was a dishwasher in the home. Wash basin taps (which are most often found in bathrooms) are thought to account for the remaining 45% of all internal tap uses in domestic properties.

➢ **Potential for improved water efficiency**

Users can change the way they use their taps to reduce overall water consumption. For example,

- Installing a water efficient tap or a tap aerator
- Turn the tap off when not in use and use a washing up bowl instead of washing under a running tap. A washing up bowl is an inexpensive and quick buy that will help cut down on water wastage.
- Avoid thawing frozen foods under running water by trying to prepare the night before.
- Fix leaky taps and check taps regularly and replace worn washers as soon as possible.
- Avoid installing a waste macerator in your kitchen sink because these require a lot of water to operate properly. Instead, dispose of food waste in a compost pile *(Waterwise (1), 2009).*

In addition, many water-saving devices exist, including retrofit devices for taps. These are illustrated in Table 5 and Table 6, and are currently available on the market.

Table 5: Water efficient taps (*UK Environment Agency, 2007*)

Device	Description
Spray taps 	Spray taps can save a significant amount of the water and energy used for hand washing but they can restrict the flow too much to fill the basin quickly.
Sensor faucets for residential use 	Some manufacturers are now offering sensor-activated faucet for the home bath. The electronic circuitry in most home units is powered by standard AA batteries, so hardwiring to the home's electrical system is not required. There also exists a solar-powered faucet with a storage cell that transforms sunlight or artificial light into electrical energy. Another self-sufficient unit operates on hydropower, using a small internal turbine to generate its own electricity whenever the water runs.

Table 6: Retrofit devices for taps

Product	Description (advantages and tradeoffs)
Push Tap 	A push tap is a retrofit tap device which basically only releases water when pressed and shuts off automatically when released; it eliminates the possibility of keeping the tap running unattended
Tap flow restrictors 	The easiest way to save water with existing basins and showers is to fit a flow restrictor. 3.75l, 5l and 6l flow restrictors available to suit taps and showers

3.1.3.3 Market trends

The market for taps in Europe, like most other WuPs, are increasing because of rising demand in additional housing and changing demographic factors (more single person homes). See sub-section 3.1.3.17 , pg. 77 for the summary of market trends for residential and commercial WuPs and for additional information on market statistics for taps in the EU.

3.1.3.4 Showerheads in residential buildings

Definition: A showerhead is defined as the point of discharge of the water.

➢ **Description of the standard showerhead in the EU**

Showerheads in the EU are usually gravity-fed, electric, or pumped. Electric showers use energy to heat the water in the unit, and thus draw water directly from a cold water supply. These types of showers heat the water as the shower is turned on, by passing it over a heating element inside the shower. Gravity-fed showers allows the hot and cold water to flow and mix under gravity from the hot and cold water tanks to the shower head. A pump shower is a shower that delivers a high flow of water at a high pressure. Pump assisted showers are also commonly known as power showers. The shower is a mixer shower with an integral pump that increases the rate of flow from the shower head. They can only be installed on low pressure, tank fed systems. A dedicated hot and cold water supply is necessary.

➢ **Factors affecting water consumption**

Showers are also a WuP found in residential buildings that consume a significant amount of water. They make up between 10-12% of the water used in the household (*Waterwise (2), 2009*). The water used by showers in residential buildings is determined by the type of shower already being used there, its flow rate, frequency of use and average time per use.

- **Potential for improved water efficiency**

A water efficient showerhead can be fitted that will give a good performance but at the same time use less water since it operates at lower flow rates. These are only suitable for fitting to showers that previously provided a relatively high flow rate. In most cases, but not all, showering is more water efficient than using a bathtub under typical circumstances. For maximum water efficiency, it is suggested to select a showerhead with a flow rate of less than 9.5 l/min (*Market Transformation Programme (3), 2008*).

There are two basic types of low-flow showerheads: aerating and laminar-flow. These types of showerheads are extremely effective at conserving water and reducing energy bills. In fact, water usage is one area most homeowners neglect when performing energy saving evaluations of their homes, but it is one of the easiest to control. Table 7 and Table 8 show currently available low-flow showerheads and retrofit devices to improve the water-efficiency of these products.

In addition to these water-saving devices, modifying use patterns of showers can improve the water efficiency of showerheads. For example, reducing the duration of a shower can be done by using a shower timer, which shows how much time has been spent in the shower.

Table 7: Low-flow showerheads

Device	Description (advantages and tradeoffs)
Aerating showerheads 	Aerating showerheads mix air with water, forming a misty spray. It maintains steady pressure so the flow has an even, full shower spray. Because air is mixed in with the water, the water temperature can cool down a bit towards the floor of the shower. Aerating showerheads are the most popular type of low-flow showerhead. They can also be used with a flow regulator for maximum water conservation.
Laminar flow showerheads 	Laminar-flow showerheads form individual streams of water. It is recommended for those who live in humid climates, because they create less steam and moisture than an aerating one.

Table 8: Retrofit devices for showerheads

Product	Description (advantages and tradeoffs)
Showerhead flow regulators 	Flow regulators for showers are easy to install and offer a quick and inexpensive way of saving water without having to create a whole new bathroom. They provide between 6 and 9 l/min flow rate, both of which allow enough water for a thorough shower. However, flow regulators cannot be fitted to electric showers.

- **Market trends**

Many key factors are currently influencing the market for showerheads. As is the case for most of the other WuPs covered in this study, the demand for additional housing, along with changing demographic factors including a higher proportion of single-person households, will influence the market growth of residential WuPs.

There is a trend towards more powerful showers and shower accessories supported by the availability of larger enclosures designed for use with higher specification showers, shower panels and body jets etc. The replacement of the bath with a shower enclosure is also increasing, particularly in smaller homes where space is more restricted and en-suite bathrooms are less common.

No significant evidence of recycling showers (wherein water once used in the showering process is held in a storage tank and recycled during a portion of the showering process in place of fresh water) was found, so it is assumed that their current impact on the market as a whole is negligible. However, they do exist and may have an impact in the future.

There is also a trend towards more powerful electric showers and features designed to improve installation. Bath/shower mixers remain popular in the new-build sector owing to the installation of en-suite bathrooms which contain a separate shower, in addition to space restrictions in the main bathroom (*Market Transformation Programme (3), 2008*).

As for water efficient showerhead devices, the market is steadily increasing as prices for these products are decreasing and people are becoming more concerned about rising water and heating tariffs.

3.1.3.5 Residential bathtubs

Definition: A bathtub is a plumbing fixture used for bathing. Most modern bathtubs are made of acrylic or fiberglass, but alternatives are available in enamel over steel or cast iron, and occasionally wood. A bathtub is usually placed in a bathroom either as a stand-alone fixture or in conjunction with a shower.

Description of the standard bathtub in the EU

Bathtubs in Europe are usually available in three main materials: reinforced cast acrylic sheet, porcelain enamelled steel, and porcelain enamelled cast iron. Baths come in a variety of designs. They may be fitted into an alcove, in a corner or in a peninsular situation. They may be freestanding and double ended for use by two. They are available in a range of sizes – the most common are 1,600 mm to 1,800 mm long and by 700 to 800 mm wide (*Bathroom Manufacturer's Association (1), 2008*).The conventional pillar tap (which was described in the sub-section on taps, pg. 45) is the most common type of tap used in baths that controls the water supply. See sub-section 1.1.1.1, pg. 95 on the water consumption of baths (for standard baths in Europe).

Factors affecting water consumption

Modern bathtubs have overflow and waste drains and may have taps mounted on them. They may be built-in or free standing or are sometimes sunken. Until recently, most bathtubs were roughly rectangular in shape but with the advent of acrylic thermoformed baths, more shapes are becoming available. The main factors affecting the amount of water used for bathing are the type of bath and its capacity, along with the frequency of usage of the bath.

Potential for improved water efficiency

Studies suggest that to improve water performance of bathtubs, showers should be used instead of taking baths for personal washing, since taking shorter showers uses less water than running a bath.

In addition, since many baths use similar taps that are found on wash basins and kitchen sinks, similar water-saving devices can also be used to improve the water efficiency (see Table 7 and Table 8 for more information).

Market trends

Studies have shown a general trend towards smaller properties, and thus the market for space saving baths and shower baths is growing (*Bathroom Manufacturers Association (2), 2008*). Space saving baths are deeper rather than long and shower baths have a wide shower area for comfortable showering and a normal bath shape at the end for lying down. Although space saving and shower baths are growing in popularity, where space is an issue many people are foregoing the bath and having a shower enclosure or wet room area only. Increasingly baths are regarded as a luxury item and in the wellness arena there will always be a demand for whirlpool baths.

Where space and budget are noobject a concern, baths of varying sizes and designs remain hugely popular with the emphasis definitely on wellness, relaxation and luxury, rather than necessity bathing.

3.1.3.6 Domestic washing machines

Definition: An appliance for automatically cleaning home laundry that has a control system which is capable of scheduling a preselected combination of operations, such as regulation of water temperature, regulation of the water fill level, and performance of wash, rinse, drain, and spin functions.

➢ **Description of the standard washing machine in the EU**

Washing laundry is a large water user in the average home and accounts for 15% to 40% of the overall water consumption inside the typical household. According to the preparatory study for ecodesign requirements on washing machines, the average capacity of the machines offered in the EU has changed from about 4.8 kg in 1997 to less than 5.4 kg in 2005 (*Presutto et al., 2007*). Water consumption of washing machines has been reduced as well - while in 1997 the majority of machines were reported at a water consumption of 75 litres, this value is now at 50 l/cycle.

➢ **Factors affecting water consumption**

Water consumption of washing machines depends on the number of occupants in the household and the frequency of use.

➢ **Potential for improved water efficiency**

In Europe, a number of devices and processes have been proposed to enhance the water performance of washing machines without increasing energy or water consumption, or wear on textiles. For example, intelligent sensor systems (load detection, turbidity sensors, foam sensors, etc.), which can automatically detect loading, staining, etc., can control programme options as well as adjust water/energy consumption accordingly. Others trends in technological advances include new washing programmes, which are suited for new textiles (e.g. sport and functional clothes) or special, delicate garments (particularly hand wash/wool programmes) and new machine time functions: time/start delay options (up to 23 h), time left/remaining, time digital displays which may help in managing the consumer available time (*Presutto et al., 2007*).

■ **Changing use patterns**

By changing use patterns, users can also significantly improve the water efficiency of washing machines:

- When using the washing machine, make sure to use a full load every time. Surveys have shown that a typical load of laundry is usually much less than the maximum capacity of the model.
- Be familiar with the washing machine's cycle options. Some settings provide the same cleaning power as a normal cycle, but with less water and energy.

Check the user manual for water consumption information about the various cycles on the model, or contact the manufacturer.

- Avoid pre-washing. Most modern washing machines and washing powders effective enough so that pre-rinse is not necessary (*Waterwise (4), 2009*).

Market trends

According to information from the European Eco-label, 13.5 million washing machines are sold each year in Europe (*DG Environment, (2) 2008*). The washing machine market in Europe is characterised by a very high penetration of washing machines in residential buildings with almost saturation in EU-15. In CEE-countries the penetration is increasing continuously. Because washing machines have a long product lifespan (an average of 10 years), replacements occur after 10 years or later. In the future it will be expected that the market will be mainly driven by a substitution of old appliances. For Europe, it was evaluated that 188 million household appliances are older than 10 years of which 40 million are washing machines.

The Energy label (introduced by the EU in 1999) played a decisive role in the development of the market of household appliances in the last decade (within the context of this study, the Energy Label applies specifically to washing machines and dishwashers). It provides the consumer with the opportunity to compare different appliances because it informs consumers about relevant consumption values concerning energy and water and provides information on performance criteria such as capacity, cleaning/washing performance or noise emissions. This leveraging of the information provided to the customer has forced "manufacturers … to introduce new, more efficient products", to remain competitive (*World Energy Council, 2005*).

Other information from the Eco-design study has identified the following main market trends for washing machines that can be applied to this study:

- increasing load capacity
- small machines (i.e. 3 kg) represent a niche but contribute a stable amount of the total available models
- industry has optimised the product's design to meet the energy consumption of the energy efficiency class thresholds
- 31% improvement in specific water consumption from 1997 to 2005 with an annual improvement of 0.28 l/kg
- in 2005 the majority of the models have a water consumption below 50 litre per cycle.

Table 9, Table 10, and Table 11 show market sales trends of washing machines in specific MS (Denmark and France).

Table 9: Sales Trends of washing machines in Denmark (*CECED, 2009*)

2003	2004	2005	2006	2007	% of change between 2003 & 2007
193,520	205,220	204,045	220,390	227,000	**+ 17.3%**

Table 10: Sales Trends of washing machines in France (values expressed in thousands (*GIFAM, 2007*)

2000	2001	2002	2003	2004	2005	2006	2007	2008	% of change 2000 & 2008
2,290	2,225	2,270	2,225	2,290	2,350	2,446	2,490	2,460	**+ 7.4%**

Table 11: Percentage of households in France that own washing machines (*GIFAM, 2007*)

1970	1980	1990	1999	2001	2003	2005	2007
57%	79%	88%	93.2%	95.1%	94.1%	95.4%	**95.3%**

From 2000 to 2008, there was a 7% increase in the sales of washing machines in France and an increase from 57% in 1970 to 95.3% in French households that own washing machines. Overall, these tables support the observation that washing machines will continue to be a popular EU residential WuP in the future.

3.1.3.7 Domestic dishwashers

Definition: A cabinet-like appliance which, with the aid of water and detergent, is designed to wash and sanitize plates, glasses, cups, bowls, utensils, and trays by chemical, mechanical and/or electrical means and a sanitising final rinse.

- **Description of the standard dishwasher**

Dishwashers consume from 6 to 14% of total domestic use of water. All dishwashers employ wash, rinse, and sanitising cycles. The sanitising cycle typically is the chemical reduction of microorganisms to safe levels on any food utensil. The time taken for a dishwasher to complete a cycle is a combination of mechanical action, water temperature, and chemical action. Hot water use varies with the pressure of supply lines, operation speed of the machine, and dish table layout. All these variables are intrinsically linked and any adjustments affect each component. For example, rapid washing cycles necessitate stronger mechanical action and more concentrated detergents for cleaning (*North Carolina Department for Environment and Natural Resources, 2007*).

- **Factors affecting water consumption**

Factors that affect water consumption for dishwashers are similar to that of washing machines and depend on cycle time, as well as frequency of use of the machine.

Potential for improved water efficiency

Whilst there is still potential for technical improvement from manufacturers, *the greatest savings are now to be achieved by using the appliances carefully*, for example only washing full loads and not rinsing dishes before putting them in the machine.

New intelligent functions (similar to those mentioned for washing machines) are being developed to help improving water efficiency and include improved sensor systems and functions which automatically detect the loading, the type of tableware and the degree of soiling to efficiently adjust the water and energy consumption as well as the programme duration.

- Changing use patterns

Users can significantly influence the water efficiency of dishwashers by modifying their use patterns:

- When using the dishwasher, make sure to use a full load every time.
- Be familiar with the dishwasher's cycle options. Some settings provide the same cleaning power as a normal cycle, but with less water and energy.
- Avoid pre-washing.

Market trends

Around 6 million dishwashers are sold each year in Europe (*DG Environment, 2004*). The dishwasher market in Europe is characterised by varying penetration rates in EU households: especially in the new Eastern MS where the penetration of dishwashers is quite low, with a steady increase of the penetration in almost all other MS. Since dishwashers are a long living product, with replacements happening after 10 years or later, there is also quite a strong substitution of installed dishwashers. The typical lifespan of a dishwasher is approximately 16 years.

The number of models offered on the market has considerably increased in recent years. This is due to increasing population growth and overall penetration of dishwashers. Smaller machines for 4 or 5 place settings (PS) play a very minor role in the market with a share below 1%, unchanged over the years. Only slightly more relevant are larger machines (about 2% of the market share) for 15 PS, replacing machines for 14 PS.

Other new features that have been observed in the market of dishwashers include aspects to improve the consumer's quality of life. For example, the reduction of noise of new appliances (from 30 to less than 60 dB), allows the integration of (silent) dishwashers. Also the reduction of the washing cycle time (up to 50%) and time pre-selecting options will play a major role in the future, because this provides the consumer with more leisure time and autonomy. Safety options (aqua stop systems, child safety, etc), already exist today and will be guaranteed in future too, but these basic features will be supplemented with intelligent options like self fault analysis, self cleaning options, etc. (*Presutto et al., 2007*).

Data from the ecodesign study has identified the following main market trends for dishwashing machines that can be applied to this study:

- the market share of small compact machines (45 cm, below 10 PS capacity) is constant in terms of market share
- very small and very large machines represent a small percentage of the (1-2% of the market)
- 22% improvement in water consumption from 1998 to 2005
- the majority of water consumption is below 15 litre/cycle for 12 PS machines[15]

Table 12: Sales trends of dishwashers in France (*GIFAM (2)*)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Values expressed in thousands	1,000	1,050	1,040	1,055	1,110	1,166	1,237	1,320	1,380

Table 13: Trends of the percentage of households in France that own dishwashers (*GIFAM (2), 2007*)

1970	1980	1990	1999	2001	2003	2005	2007
3%	17%	32%	43.2%	45.1%	48.1%	50.6%	53.7%

Table 12 and Table 13 show sales trends and the percentage of households in France that own dishwashers. From 2000 to 2008, there was a 38% increase in sales of dishwashers in France and an increase from 3% in 1970 to 53.7% in French households that own dishwashers.

3.1.3.8 Commercial urinals

Definition: A fixture, typically one attached upright to a wall, used by men for urinating.

- **Factors affecting water consumption**

The frequency of toilet flushes per toilet is often greater in offices than homes, although the frequency is highly variable from facility to facility. Depending on the type of commercial activity carried out in the building, customers might also incur additional flushing activity. Urinals are often set to flush regardless of use. This could lead to a lot of water is wasted. In addition, urinals must be flushed at the minimum frequency necessary to remain hygienic (*UK Environment Agency, 2007*).

- **Potential for improvement**

Many flush controller designs are available. These either use a timer to match the hours of use or detect the presence of people. This is typically achieved by means of infrared movement detectors or door switches. Mechanical designs use water flow or

[15] Ibid.

variations in pressure caused by taps being used, to open a valve to the urinal cistern. Some controls allow the urinal cistern to fill slowly unless no activity has been detected for a preset period. The following devices in Table 15 can also be used to control flush frequency and increase water efficiency.

- **Market trends**

A recent water conservation market penetration study was carried out in the East Bay Area of California (United States of America - USA) (*East Bay Municipal Utility District, 2002*). The study surveyed the types of urinals used in commercial settings to assess the penetration of water efficient urinals in different sectors.

The study indicated that the total penetration of low flush urinals (with a rated flush volume below 3.8 lpf) was between approximately 22 and 24% (Table 14). In-depth and reliable market data for urinal production, sales and trade in Europe could not been identified. The commercial sector, however, scored very low, accounting for only 5.9% of the market share. Across all sectors there is potential to introduce an increasing number of water efficient urinals.

Figure 11 shows the findings of this study where in most cases there are a high percentage of urinals that use less than 3.8L per flush. However, a large percentage of urinals in the commercial sector were found to use between 4.2L and 7.6 litres per flush. Offices in particular had a high percentage of urinals that operated within this range. This may indicate that offices could be a future target for increasing urinal flush efficiency. It is worth noting however that, with the exception of the commercial sector, the majority of urinals could not be rated according to flush volume (classified as 'Unknown').

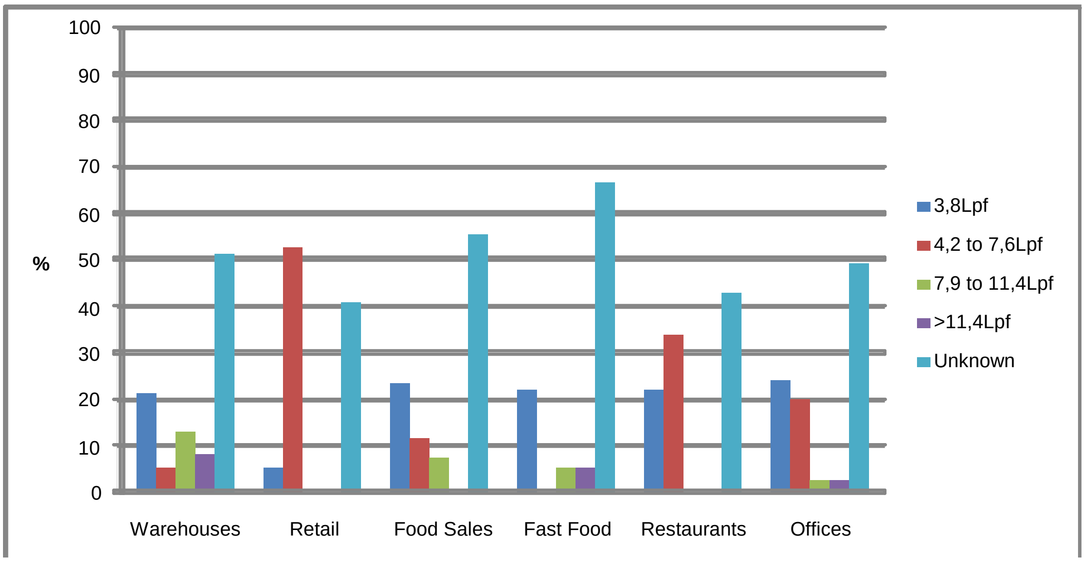
Table 14: Market penetration of low flush urinals

Product	Percentage of Market in Each Sector Surveyed					
	Warehouses	Retail	Food Sales	Fast Food	Restaurants	Offices
Low Flow Urinals	21.6	5.9	24.0	22.2	22.7	24.4

Table 15: Water-efficient urinals

Device	Description
Hydraulic valve 	A hydraulic valve (pressure reducing valve) can be fitted to the inlet pipe work of the urinal system. When the inlet water pressure decreases temporarily through water being used elsewhere in the washroom (e.g. WC toilet flushing or hand washing), the diaphragm operated valve opens, allowing a pre-set amount of water to pass to the urinal cistern. When the cistern is full, the auto-siphon will discharge and flush the urinal. When the washroom is not being used, the pressure remains unchanged and the valve remains closed (*Envirowise, 2005*).
Passive infrared sensor 	Passive infrared sensors identify when the urinal has been used (or when someone has stood in front of it and moved away), and activate the flush. Thus the urinal is cleaned, where with a manual flush it might not have been, but water is not wasted when the toilet is not used. A passive infrared (PIR) sensor can be installed in the washroom to detect use of the urinal facility. This sensor controls a solenoid valve to allow a pre-set amount of water into the cistern per use. When the cistern is full, the auto-siphon will discharge and flush the urinal.
Waterless urinals 	Waterless urinals work without using any water other than for routine cleaning. Some systems are supplied as a complete unit, while others can be retrofitted to standard bowls and troughs. They offer significant water savings and address some of the problems associated with conventional urinals, namely scale, odour, blockage, and subsequent flooding.
Timed Urinals	A timed flush operates automatically at regular intervals. Groups of up to ten or so urinals will be connected to a single overhead cistern, which contains the timing mechanism. A constant drip-feed of water slowly fills the cistern, until a tripping point is reached, the valve opens (or a siphon begins to drain the cistern), and all the urinals in the group are flushed. Electronic controllers performing the same function are also used. This system does not require any action from its users, but it is wasteful of water where the toilets are used irregularly.
Cistern valve Adjuster	Flush volumes can be optimised by reducing the cistern size or by installing a cistern volume adjuster (CVA). It is a simple device is either filled with or absorbs water (1.5 - 2 litres) once it is inserted in the cistern, thus reducing the volume of the cistern. However, each pan design has a minimum flushing volume and not all CVAs are appropriate for all types of cistern.

Figure 11: Distribution of urinals by rated flush volume



3.1.3.9 Commercial taps

- **Description of the standard commercial tap in the EU**

Taps can waste large amounts of water, as they are the most heavily used water source in kitchens. Information on commercial taps is similar to those found in homes. See section 1.1.1.1, page 45 on residential taps for a general description of the standard tap.

- **Potential for improvement**

Spray taps can save a large amount of water and energy used for hand washing but they can restrict the flow too much to fill the basin quickly. A clever invention that aims to address this problem is the Tap magic insert, which can be fitted to most taps with a round outlet hole or standard metric thread. At low flows, the device delivers a spray pattern suitable for washing hands or rinsing toothbrushes. As the flow is increased, the device opens up to allow full flow to fill the basin.

Sensor taps and timed turn-off push taps prevent wastage and flooding where taps may be left running. They also offer improved hygiene, as the tap does not have to be touched after hands have been washed. To make sure savings are achieved and the user is satisfied, the fitting must suit the water pressure and allow for correct adjustment.

Another innovation is a water-saving cartridge for single-lever mixer taps. As the lever is lifted, resistance is felt. If a higher flow is needed, the lever can be pushed past this step. Some designs make sure that only cold water comes out when the lever is in the middle position.

Where water is supplied at mains pressure, an aerator or laminar flow device can eliminate splashing. These devices can incorporate flow regulators and provide the illusion of more water than is actually flowing. Available flow rates for basin taps include 8, 6 and 5 l/min. All provide plenty of flow for using directly or filling a small basin (*UK Environment Agency, 2007*).

Water-saving devices for commercial faucets are very similar to those discussed for taps used in homes.

- **Market data and trends**

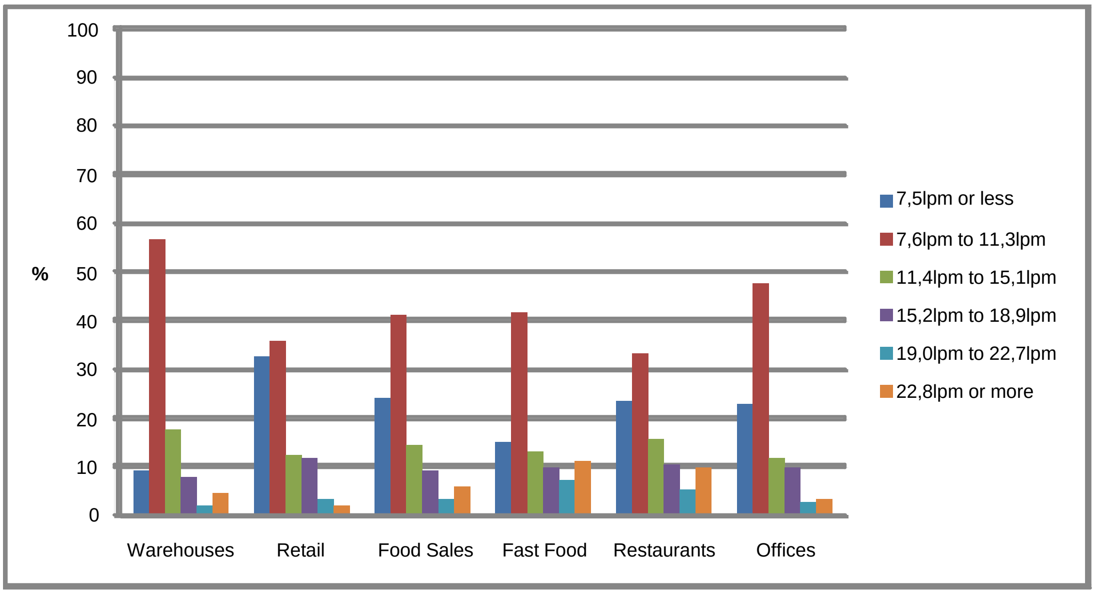
Data from the U.S. East Bay Area study has revealed that across all commercial sectors, the majority of taps use a flow rate of 7.6 to 11.3 l/min. With the exception of warehouses, low flow taps take up the second largest share across all sectors.

Despite the low percentage of lower flow taps in the warehouse sector, it has one of the highest market penetration percentages for tap aerators. It is rivalled only by offices, where aerators have a 78.3% market share as is indicated in Table 16.

Table 16: Market penetration of tap aerators

Product	*Percentage of Market in Each Sector Surveyed*					
	Warehouses	*Retail*	*Food Sales*	*Fast Food*	*Restaurants*	*Offices*
Taps containing Aerators	72.2	65.9	60.8	60.1	57.5	78.3

Figure 12: Distribution of non-residential taps by flow rate



Aerators appear to take up a large share of the non-residential tap market, although there appears to be room for increase. It is important to note, once again, that the above figures relate to a specific area within a non-European country. Aggregated production data has been obtained from the PRODCOM database which does not distinguish between residential and commercial taps. This data has been included in sub-section 3.1.3.17, page 77 below on overview of markets trends for WuPs found in the building sector.

3.1.3.10 Commercial toilets

- **Description of the standard commercial toilet in the EU**

Commercial toilets can be found in establishments such as schools, hospitals, businesses, airports, etc. According to Defra, toilets can comprise half of the water used in commercial offices (*Defra, 2008*). It is important to distinguish toilets in commercial and residential settings because there are significant differences – both in their physical construction and operation – between these toilet installations.

For example:

- Installation settings: commercial fixtures are often installed on 4-inch diameter drain pipes set at a 1% slope whereas residential fixtures are typically installed on 3-inch diameter pipes set at a 2% slope
- Use capacity: commercial toilets, which are often required to flush paper toilet seat covers, paper towels, large amounts of toilet paper, etc., are typically subjected to a much greater waste loading than residential toilets
- Drains and sewage systems: the lengths of drain runs are often much longer in commercial installations, and
- Supplemental flows: supplemental flows are often much less in commercial installations (supplemental flows from bathing, clothes washing, etc., help transport waste through drain lines) (*Alliance for Water Efficiency (4), 2009*).

- **Factors affecting water consumption**

As already mentioned in the section on residential toilets, the frequency of toilet flushes determines overall water consumption. The frequency of toilet flushes per toilet is often greater in offices than homes, although the frequency is highly variable from one facility to another. Similar to commercial urinals, depending on the type of commercial activity, customers might also incur additional flushing activity.

- **Potential for improvement**

Water saving toilets have been introduced into residential applications because of favourable conditions such as smaller diameter drain piping, steeper slope, and availability of supplemental flows; however, there has been some debate about the use of these toilets in all commercial applications. The main issues in installing them in commercial sites are the drain lines. With little or no supplemental flows, drain line problems can occur because of the decreased flush volumes of the highly efficient toilets and lack of supplemental flows (from showers and tap use). Therefore, careful attention should be made when deciding whether to install High-Efficiency Toilets (HETs).

- **Vacuum toilets**

Vacuum toilets are not usually found in buildings. These types of toilets are often seen in transportation facilities such as aircrafts, ships, and trains. However, some exceptions do exist in the case of vacuum toilets found in buildings. For example, some hospitals provide vacuum toilets to collect the excreta of people treated by radioactive substances. Vacuum toilets are so far used under conditions, where there are special requirements for transport or the necessity of storage of the toilet's effluent. Vacuum toilets use between 0.3 to 1.4 litres of water per flush (*Maksimović et al., 2003*; *Grant, 2002*).

All available vaccuum toilet systems use zero water but some require electricity. Dry toilet designs are evolving but are mostly intended for rural sanitation. Vacuum technology may have wider application but would require some technical problems to be solved if it is to be used on the domestic scale whether in individual dwellings or blocks of flats. Finally cost and life cycle issues must also be considered (*Grant, 2002)*.

- **Market trends**

As shown in Figure 13 , non-residential toilets with a rated flush volume below 6.1 litres appeared to take up a greater share of the market across all sectors, with the exception of warehouses (*East Bay Municipal Utility District, 2002*). If the scenario is assumed to be comparable to that of Europe, there is potential for improvement. When looking at the overall market penetration within each sector, low flush toilets appear to lead, with a minimum of 31.8% of the market share.

Figure 13: Distribution of non-residential toilets by rated flush volume

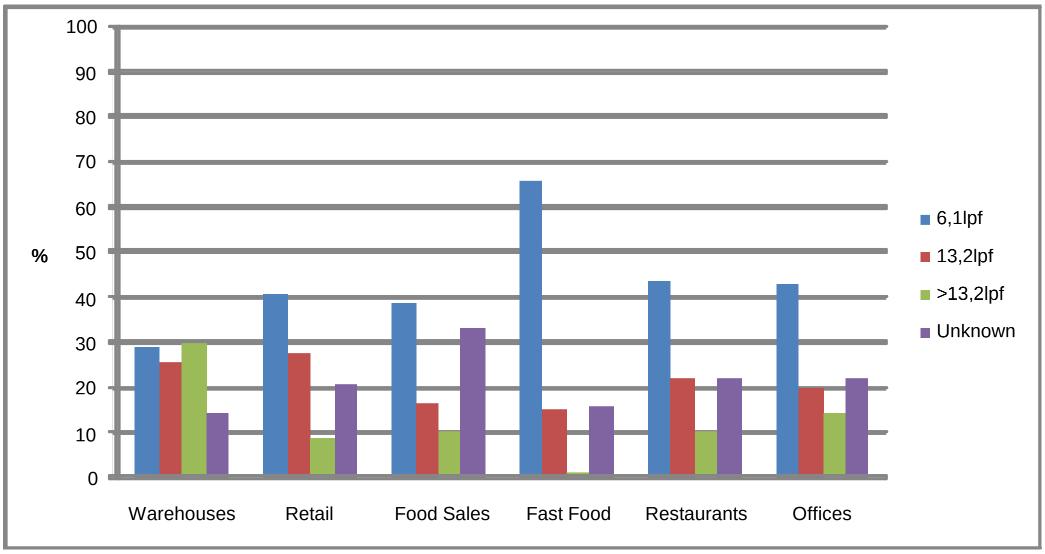


Table 17: Market penetration of non-residential ultra low flush toilets

Product	*Percentage of Market in Each Sector Surveyed*					
	Warehouses	*Retail*	*Food Sales*	*Fast Food*	*Restaurants*	*Offices*
Ultra Low Flush Toilets	31.8	45.4	47.2	68.0	44.1	49.8

A recent study identified that in restaurants, the percentage of non-commercial low flush toilets used has grown significantly, from 11.9% to 44.1% over a period of 10 years (until 2001) (*East Bay Municipal Utility District, 2002*).

Once again, the above data may provide some information on market penetration; although the figures may not be applicable to Europe. Aggregated production data has been obtained from the PRODCOM database which does not distinguish between residential and commercial toilets, which is seen in Table 17. This data has been included in sub-section 3.1.3.17, page 77 below. In depth market data for commercial toilet production, sales and trade in Europe could not be identified.

3.1.3.11 Commercial ice makers

Definition: Ice-makers are machines used to produce ice either ice cubes, flake ice or crushed ice. Typical applications include ice storage in food preparation and display (hostel, restaurants), for ice sales to customers, fish storage on boats, and for drinks in food retailing.

- **Description of the standard commercial ice maker in the EU**

Ice-makers are present in many commercial sites such as in hospitals, hotels, restaurants, retail outlets, schools, offices, and grocery stores.

There are two basic ice-maker equipment designs: air-cooled refrigeration units and water cooled refrigeration units.

Ice-makers can be of different types depending on the type of ice produced, e.g. ice cubes, ice nuggets, ice flakes. The type of ice produced is foreseen as a significant parameter to take into account, e.g. one leading manufacturer of ice-makers in the US states that nugget ice-makers have advantages over cube type machines in both energy consumption and water consumption.

- **Potential for improvement**

The performance of ice-makers can be improved by a range of measures, some of which are applicable to most refrigeration systems. These typically include the use of:

- appropriate thermostatic controls, time-clocks and/or switches to control the operation of the ice maker;

- capacitor start compressors: these increase compressor efficiency from around 45% to between 50% and 55%;
- incoming water to help loosen ice rather than heating already chilled water;
- high-efficiency motors for the condenser fans, where relevant;
- high efficiency fan blades;
- mechanical assist defrost;
- a heat exchanger to pre-cool the incoming water, using the cold drain water;
- high insulation levels for ice storage bins;
- careful selection of the correct size of machine and bin.
- an efficient ice machine uses no more than 20 gallons per hundred pounds of ice made; and
- flake ice machines are even more water efficient, using 12 gallons per 100 pounds of ice (*Mark Ellis and Associate, 2004*).

➢ **Market trends**

Worldwide commercial ice machine shipments increased by 62% between 1989 and 1999 (Table 18). It is believed that as the number of food and beverage related businesses grow, so too will the number of ice machines produced. At present the current European ice machine stock is estimated to be above 3.3 million units. Furthermore, sales are estimated to be around 0.4 million units per year, indicating a potentially significant market in Europe.

Table 18: Worldwide shipment value of ice machines (*Deneen, 2001*)

Product	*Shipment (millions of dollars)*		
	1989	*1994*	*1999*
Ice Machines	830	1,040	1,345

In-depth information on market trends for these types of products could not be identified.

3.1.3.12 Commercial washing machines/laundries

Definition: A commercial washing machine is intended for more frequent, a tougher duty cycle, and long-term usage than a domestic washing machine.

➢ **Description of the standard commercial washing machine in the EU**

Many commercial washing machines are built for use by the general public, and are often installed in publicly accessible laundromats or launderettes, operated by money accepting devices or card readers. The features of a commercial laundromat washer are more limited than a consumer washer, offering just two or three basic wash types plus an option to choose wash cycle temperatures. Such washing machines are also found in commercial settings such as hotels, nursing homes, prisons, universities, and hospitals.

Commercial washers for business include some extra features that are not seen in domestic washing machines. For example, many commercial washers offer an option for automatic injection of five or more different chemical types, so that the operator does not have to deal with constantly measuring soap products and fabric softeners for each load. Instead a precise metering system draws the detergents and wash additives directly from large liquid-chemical storage barrels and injects them as needed into the various wash and rinse cycles.

Liquid chemicals are usually preferred because of the ease of administration through a series of peristaltic metering pumps. These pumps are programmed to deliver precise amounts of chemical during the appropriate phase of the wash and take their signal from the washer controls.

➢ **Potential for improvement**

Although laundries consume large amounts of both energy and water, conservation opportunities in this arena are relatively untapped, and thus are ripe for the introduction of new technologies that can meet the industry's reliability and cost-effectiveness expectations.

Several factors must be met for any new technology to be successful in the laundry environment. Not only must the technology meet all of the customer's financial criteria, it must also meet operational and maintenance requirements, and physical space constraints. Naturally, the technology must work with very high reliability and it must be maintainable by the "in-house" maintenance personnel with minimal additional work or have a low cost program for maintenance available from the manufacturer (*Riesenberger, 2005*).

➢ **Market trends**

Aggregated production data has been obtained from the PRODCOM database which does not distinguish between residential and laundry type washing machines, which is seen in Table 19. This data has also been included in sub-section 3.1.3.17, page 77.

Table 19: Water efficient technologies for commercial washing machines

Device	Description
AquaRecycle	AquaRecycle is a wastewater recycling system designed and sold only in commercial laundry applications by EMI Water Recycling Systems since 1998. It is considered a full recycle system and is designed to recycle 100% of the wastewater from the wash and rinse cycles and it reapplies this water throughout the entire array of succeeding wash and rinse cycles. Aquatex 360 - Wastewater Resources, Inc. (WRI) has developed a system called Aquatex 360, specifically designed for recycling water in commercial laundries
Ozone Laundry Systems	Ozone is a very strong oxidant that works well in cold water thereby saving a great deal of water heating energy when compared to conventional laundry processes. Additionally, because of the unique oxidation properties of ozone, there is a theoretical Since ozone is so unstable and cannot be shipped or stored, it must be made at the point of use.
Rinse Water Recovery Technologies	One of the concepts utilised in laundries in the past has been rinse water recovery. This type of system works by diverting water recovered from rinse-only cycles into a large holding tank near the laundry wash line. Whenever a washer calls for water in a soak, suds or wash cycle, the water stored in the rinse water holding tank is pumped into the washers. One manufacturer, Thermal Engineering of Arizona (TEA), has been successful in installing their system in several institutional properties, such as Veterans Administration hospitals and state prisons, but these systems are not found in typical commercial laundry applications. They involve high initial cost, and very long payback periods, making them often unattractive in commercial settings

3.1.3.13 Commercial dishwashers

Definition: A cabinet-like appliance which, with the aid of water and detergent, is designed to wash and sanitise plates, glasses, cups, bowls, utensils, and trays by chemical, mechanical and/or electrical means and a sanitising final rinse.

- **Description of the standard commercial dishwasher in the EU**

Commercial dishwashers are considered to be one of the largest water consumers in commercial kitchens, often using more than two-thirds of the overall water use. The equipment can vary widely in size and shape. Classes of commercial dishwashers include under counter, stationary rack door type, rack conveyor machines and very large flight type (continuous conveyor) machines. Each of these product classes may employ single or multiple wash tanks, and use hot water (high-temp machines) or chemicals (low-temp machines) to achieve final rinse dish sanitisation.

All commercial dishwashers have at least one tank that provides hot water with a temperature ranging from 110°F to 140°F. High-temp machines require an additional booster water heater to provide sanitised hot water above 82.2°C (180°F) during the rinse cycle.

Using water softener can reduce mineral deposits on the heating element and will help the machine work more efficiently. Otherwise, the salts that break out of the water during the heating process can attach themselves to the heating element and to pipe work, where they can cause serious damage to the machine.

- **Potential for improvement**

Lowering the rinse water consumption not only saves water, but also presents the most significant opportunity for energy savings for this product. Several additional devices exist that can be fitted onto or used in conjunction with commercial dishwashers to improve water performance. Following are some examples:

Typically, large restaurants and food service operations utilise commercial dishwashers. Prior to loading the dishwasher, plates and dishes receive manually sprayed water (pre-rinsed) to remove loose or 'sticky' food. The washing of dishes typically consumes two-thirds of all water used from the restaurant. Water used in this pre-rinsing operation is often twice the volume of water used by the dishwashing equipment. The most cost-effective water conservation measure in a commercial food service operation is improving the efficiency of the pre-rinse spray valve.

Technologies that can improve the energy and water efficiencies of commercial dishwashers include:

- Wash tank insulation
- Wash compartment insulation
- Sensors to control conveyor movement
- Multi-staging systems that reuse rinse water to pre-rinse dishes
- Built-in booster heaters
- Built-in heat exchangers
- Advanced rinse nozzles
- Infrared burners
- Double wall construction

Since the life expectancy of a commercial dishwasher is 20 to 25 years, high efficiency units offer the potential for substantial energy and water-use savings. Extra cost for efficient dishwashers over standard models suggests a total lifecycle cost for efficient models is always a wise investment when a consumer is already planning to purchase a dishwasher.

The high cost of dishwashers may thwart early replacement (where a pre-existing dishwasher is still operating) efforts based on water and energy savings alone; local utility prices and volume of use for the equipment will dictate the cost-effectiveness for early replacements. Large restaurants with all day service (often found in large hotels) will save water at a faster rate than small, single meal service type restaurants. Utility agencies need to analyse if cost-effective financial incentives are great enough to induce restaurant owners to replace dishwashers still in good operating condition. Water agencies often accept payback periods as long as 20 years; while restaurant owners seldom invest in any energy and water efficiency with more than a 5 year payback period (*Food Service Warehouse, 2009*).

Using water softener can reduce mineral deposits on the heating element that will help the dishwasher work more efficiently. Otherwise, the salts that break out of the water during the heating process can attach themselves to the heating element and to pipe work, where they can cause serious damage to the dishwasher.

- **Market trends**

Data gathered from the PRODCOM database, category 29.24.60.00 '*Non-domestic dish-washing machines*' has revealed that non-domestic dishwashers have a large share in the European market, with over 373 000 units produced in 2007 (Table 20). Production in Europe has increased by approximately 14.4% between 2004 and 2007.

Table 20: Production of commercial dishwashers in Europe

Product	2004	2005	2006	2007
Non-domestic dish-washing machines	329 895	346 280	343 999	373 219

However, trade figures for this period show that a large number of units are exported from the EU, more than the units imported (Table 21). In 2007, exports accounted for approximately 27% of total production. However, the percentage of exports to annual production is similar for previous years. This confirms that the commercial dishwasher sector is a growing market.

Table 21: European trade data for commercial dishwashing machines

Product	2004		2005		2006		2007	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Non-domestic dish-washing machines	91 130	8 381	102 480	12 808	74 659	15 831	100 778	20 587

3.1.3.14 Commercial car washes

- **Description of the standard commercial car wash in the EU**

Commercial car washes constitute a highly visible use of water in the commercial sector. There are three main types of professional car washers – conveyor, in-bay automatic, and self-service car washes.

Conveyor Car Wash - There are two types of conveyor cars washes: full-service and exterior only. The professional full-service wash cleans the exterior and interior and the customer waits outside the car while the wash proceeds. During the professional exterior only wash, the driver stays in the car. The car moves on a conveyor belt during both types of washes. In addition to the division based on level of service, there are two basic technologies for the wash cycle, friction, and frictionless. The friction conveyor uses brushes or other material or curtains made of strips of cloth, while the frictionless conveyor uses high-pressure nozzles for a touch-free wash.

Roll-over/In-Bay Automatic Car Wash (IBA) - Mostly found at gas stations and the coin-operated car wash, the driver pulls into the bay and parks the car. The vehicle remains stationary while a machine moves back and forth over the vehicle to clean it, instead of the vehicle moving through the tunnel. Professional in-bay car washes use nylon brushes or other material, soft cloth strips or touch-free automatic washers.

Self-Service Car Wash - This car wash allows the consumers to wash the car themselves. A high pressure hose dispenses water and cleanser at varying amounts and pressures. Often a low-pressure brush is offered to assist in the wash cycle (*Brown, 2002*).

- **Potential for improvement**

Several actions and technologies exist to improve the water efficiency of professional car washes.

- **Water reclaim technology**

The primary function of a wash water reclaim unit is to collect, treat, store and re-use the effluent produced from washing vehicles. These units offer cost and space effective solutions to reduce water consumption.

There are two sub-categories of water reclaim units: partial reclaim and full reclaim systems. Partial reclaim systems are generally cheaper than full or total reclaim systems and, as a result, are more common. Typically, a partial reclaim system will recover up to 65% of wash-water and requires significant water input from an additional source to compensate for the losses from previous washes. However, this may be done in a sustainable way if the supply is augmented from, for example, harvested rainwater.

Although there is an obvious benefit of a wash-water reclaim unit in reducing water costs, it should be noted that the system requires continual maintenance. Typical issues include changing and cleaning filters, as well as regular checks to ensure the equipment is in good working order. The following example illustrates how a carwash could save money through investment in vehicle wash-water recycling technology:

A typical carwash will wash 84 vehicles per day using 21 cubic litres at a cost of £30.66 per day. Over 1 year, the cost of water would be about £11 190. A Total Water Reclamation System would recover 95% of the water used, generating a saving of £10 630 and reclaiming 7 282 litres of water per year. The cost of a Total Water Reclamation system (including civil works) would be in the region of £17 000; so payback would be approx 1.5 years (*Eco-water, 2008*)

Professional car wash water reclamation has been in use and growing in sophistication for at least three decades. Reclamation is getting more attention in the past several years from regulators and manufacturers as a means of water conservation and quality control (*Brown, 2002*). Some of the possible options to reduce water consumption in commercial car washing services are listed in Table 22.

Table 22: Actions to reduce water consumption at car washes (*Brown, 2002*)

Type of Car Wash	Steps to reduce water consumption
Self-Service	• Reduce nozzle size. • Reduce pressure. • Turn-off spot-free rinse. • Discontinue bay/lot wash down. • Discontinue landscape water. • Reduce hours of operation.
In-Bay Automatic	• Cut out soap pass, if more than one pass. • Reduce nozzle size. • Eliminate spot-free rinse, underbody rinse, rocker panel pass. • Increase speed of cycle times. • Reduce pressure. • Discontinue bay/lot wash down. • Discontinue landscape water. • Reduce hours of operation.
Conveyor	• Utilise all steps from self-service/in-bay automatics. • Place floats on towel washing machines. • Speed up the conveyor - Reduce rinse cycles to no more than 40 seconds per car. Increasing conveyor speed is the easiest means of achieving water savings in this manner. • Turn off one or more arches. • Reduce prepping, turn off prep guns. • Re-arrange nozzles on the top and sides of arches - use gravity to assist the wash and rinse process: bigger nozzles placed on top, and smaller nozzles on sides.

Waterless car wash

A waterless car wash or dry wash is a technique used to wash a vehicle without using of water. This technique uses a product that contains a mix of ingredients, including wetting agents, lubricants, surfactants and protectants. Many of these products currently exist on the market. See Figure 14 for some examples.

Figure 14: Examples of waterless car wash products available in the EU


(UK)[19]


(DE)[20]


(FR)[21]

Market trends

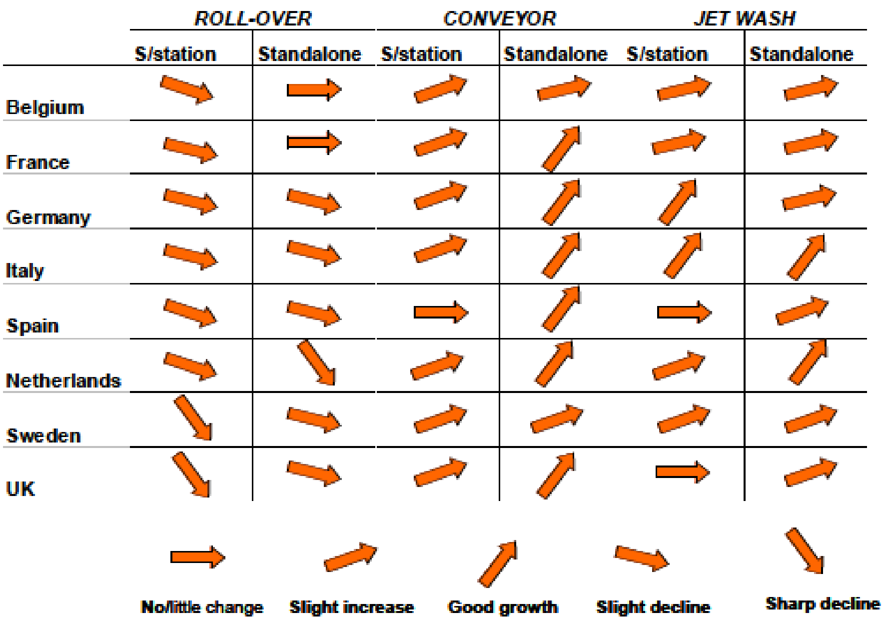
[19] http://www.aquanought.co.uk/shop/

[20] http://www.saramedia.de/shineneu.htm

[21] http://www.econo-ecolo.org/

Recent surveys show that France, Belgium and the Netherlands are expected to be the fastest growing car wash markets in 2007. Average site throughputs in Belgium were the highest in 2002 and are expected to increase for both tunnels (conveyer) and jet wash to 2007. German and Spanish motorists washed their cars most frequently in 2002 (*Research and Markets, 2003*). Figure 15 illustrates the trends that were expected to occur in the carwash market for 8 MS in 2007. The figure shows the number of roll-over installations was expected to decrease in all MS, both in service stations and as stand-alone washers. Conversely, the number of conveyer car washes was expected to increase, especially stand-alone washers. Finally, jet washes (which can include self service car washes) were predicted to experience a slight increase in both number of sites and stand-alone installations.

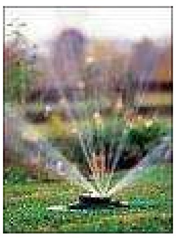
Figure 15: Growth in car wash sites/installations by type (*Datamonitor, 2001*)



3.1.3.15 WuPs in both residential and commercial buildings

The products discussed in this sub-section are those that are found in both residential and commercial buildings with little differentiation in terms of product design, user behaviour, or product functionality. This includes mainly outdoor WuPs such as sprinklers, hoses, and pressure washers and cooling systems.

➢ **Residential and commercial outdoor WuPs**



Definition: A watering system using various technologies to disperse water for growing plants, watering a lawn, or washing a vehicle.

The most common reason for outdoor water use in households is to maintain gardens and lawns, as well as for washing cars. Businesses (excluding those in the agricultural sector) that use irrigation equipment use similar devices that are found in residential properties except at a larger scale. Examples of businesses that use these types of larger scale irrigation equipment include golf courses (to maintain golf terrains) and landscaping companies. Irrigation equipment includes devices such as hoses, impact rotor sprinklers to valves, controllers, and drip emitters.

- **Sprinklers**

While sprinkler heads come in myriad sizes, shapes, brands, and styles, there are four basic types of sprinkler heads:

- Pop-up spray and rotor heads
- Impact rotors
- Gear-driven rotors
- Large turf rotors

In the United Kingdom, lawn areas are normally watered using popup sprinklers, which rise up from within the lawn when watering commences. Inside each sprinkler there is a gear drive which causes the sprinkler head to rotate back and forth. Once watering has finished they retract down below the turf level, making them virtually invisible. Larger models even have turf caps to make them completely invisible.

Depending on the model, a sprinkler can cover a radius between 3 m and 30 m. Sprinklers are spaced out to ensure a reasonable overlap between sprinklers. Windy sites need a greater overlap than sheltered positions as the wind will cause drifting. Sprinkler heads, are an integral part of many residential irrigation systems designed to distribute water to the landscape. An automatic sprinkler system can be simply programmed, turned on and left to run.

- **Hose-pipes**

A hose-pipe or garden hose is a flexible tube used to carry water. There are a number of common attachments available for the end of the hose-pipe, such as sprayers and sprinklers (which are used to concentrate water at one point or over a large area). Hose-pipes are also used for filling of portable water buckets to wash vehicles and water gardens.

Hoses are usually attached to a hose spigot (tap), which is connected to the house's main water supply. Hose-pipes are typically made out of synthetic rubber or soft plastic, reinforced with an internal web of fibres. As a result, most hose-pipes are flexible and their smooth exterior facilitates pulling them past trees, posts and other obstacles. They are also generally tough enough to survive scraping on rocks and being stepped on without damage or leaking.

For most normal sized residential gardens, using a hosepipe instead of sprinklers are much more efficient however, manual watering is more time and labour intensive and requires regular attention and vigilance.

- **High pressure hoses (or pressure-washer hoses)**

A pressure washer relies on a high pressure jet of water to clean surfaces. Pressure washers may be supplied as either electric or fuel powered (diesel, gasoline or gas) units. They are often used in residential and commercial settings to wash homes, buildings, and sidewalks. Besides cleaning dust, dirt, or bird residuals from the house or building, pressure washing houses can be done in preparation for new paint by removing chalking residues from old oil or latex paint. Deck cleaning is another common use for pressure washers. These hoses are similar to those found in industry. See sub-section 3.2.3.3 pg. 123 on industry cleaning equipment and pressure washers for further information.

- **Factors affecting water consumption**

The average amount of water used outdoors (which includes watering gardens, lawns, and washing cars) in European households varies greatly according to climatic conditions. For example in the UK, water used outdoors accounts for only about six per cent of the amount of domestic water used each year. However, on hot summer days, when supplies are tightest, over 70% of the water supply may be used for watering gardens. Thus, average household water usage demand tends to be highest in the warmer months, at times when water can be in short supply.

- **Potential for improved water efficiency**

Table 23 lists existing water-saving technologies to improve the water efficiency of outdoor WuPs. In particular, smart controllers are an emerging technology for adjusting watering applications based on actual weather and soil conditions. According to the Irrigation Association's Smart Water Application Technology (SWAT) program, smart controllers estimate or measure depletion of available plant moisture to operate an irrigation system that replenishes water as needed while minimising excess. A properly programmed smart controller makes irrigation adjustments throughout the season with minimal human intervention. The technology to control irrigation application automatically has been included in large-scale commercial systems for some time, but is relatively new to the residential and small commercial sectors. Over the past five years the number of smart controller products on the market has increased dramatically with different manufacturers opting for different control technology solutions. Two fundamental irrigation control technologies have been implemented to manage water use in the current crop of smart controllers - (1) sensor based control; or (2) signal based control (*Alliance for Water Efficiency (2), 2008*).

  - **Hose-pipe bans**

Hose-pipe bans have been imposed in Europe, which means that people are not allowed to use a hosepipe or sprinkler for watering domestic gardens or washing cars. Hosepipes and garden sprinklers can use as much water in an hour as a family of four in a day, so restrictions on their use can make a real difference, particularly at times of high water demand. A hosepipe ban mainly affects domestic customers and is designed to reduce water consumption with the least impact on lifestyle and livelihoods (*Horton et al., Date unknown*).

- **Changing use patterns**

Modifying use patterns of outdoor WuPs can have a significant impact on overall water efficiency. The following sub-sections show ways users can change their use of outdoor WuPs for water-savings (*Cambridge Water Company, 2008*).

- *Watering gardens and lawns*

Using rainwater is an excellent way to save water when maintaining gardens and lawns. Collecting the rainwater in a water butt (see Table 23) fed by gutters is an effective way of storing rainwater to be used later for watering. Some water used in the home can also be recycled and reused for use on the garden, i.e. water that has been run-off, or water used to clean vegetables. For lawns, grass can survive for long periods without water and will quickly recover from drought, thus it can be watered less frequently. In addition, heavy watering of lawns encourages the roots to come to the surface, thus rendering it less tolerant to dry conditions.

- **Automatic watering**

Hosepipes and sprinklers are expensive to use because of their high water consumption rate and thus play a factor in their use patterns. Trigger devices are available which fit onto hosepipes so the water can be turned off easily. Sprinklers that project water high up into the air waste water because much is lost through evaporation. Sprinklers or any other kind of watering system which uses water from the mains should have a water meter fitted as this will measure all the water used at the property so that users pay for what is used. Finally, taking a car to a commercial car wash instead of washing it at home can also provide significant water-savings (see 3.1.3.14 on commercial car washes).

Market trends

Preliminary market research on residential and commercial outdoor WuPs has not uncovered any significant data sources for this product sector. However, some PRODCOM data was identified in Table 23 that can be used to get an overall picture of the market for residential garden irrigation products. Overall the data shows that “agricultural or horticultural water appliances” have increased since 2004, although there was a slight decrease in production from 2006 to 2007. It should be noted however, that the PRODCOM classification for “agricultural or horticultural watering appliances” does not specify whether data is for both or either domestic or commercial products, nor does it specify particular watering appliances.

Table 23: Production quantity for “Agricultural or horticultural watering appliances”—Classification according to PRODCOM

2004	2005	2006	2007
5 600 000[22]	4 889 810[23]	9 402 636[24]	9 234 588[25]

[22] This total has been rounded to the base given in the BASE indicator
[23] This total is constructed from the EU25 total shown, plus the sum of the "EU2" countries rounded to the base given in the BASE indicator
[24] At least one of the national figures in this EU aggregate is estimated

Table 24: Water efficient home watering systems

Device	Description
Sensor Based Controllers	A sensor-based controller uses real-time measurements of one or more locally measured factors to adjust irrigation timing. The factors typically considered include: temperature, rainfall, humidity, solar radiation, and soil moisture. A sensor-based system often has historic weather information (i.e. an ET curve) for the site location programmed into memory and then uses the sensor information to modify the expected irrigation requirement for the day.
Signal Based Controllers	A signal-based controller receives a regular signal of prevailing weather conditions via radio, telephone, cable, cellular, web, or pager technology.
Recovering rainwater/Water butts 	Rainwater from guttering can be used untreated (after coarse filtering to remove leaf and other debris) on gardens or for vehicle cleaning. It involves collecting the water from roofs. The most common method of storage is to use a water butt. Afterwards, using rainwater from a water butt can be used to water plants or in a drip irrigation system.

3.1.3.16 Cooling systems used in residential and commercial buildings

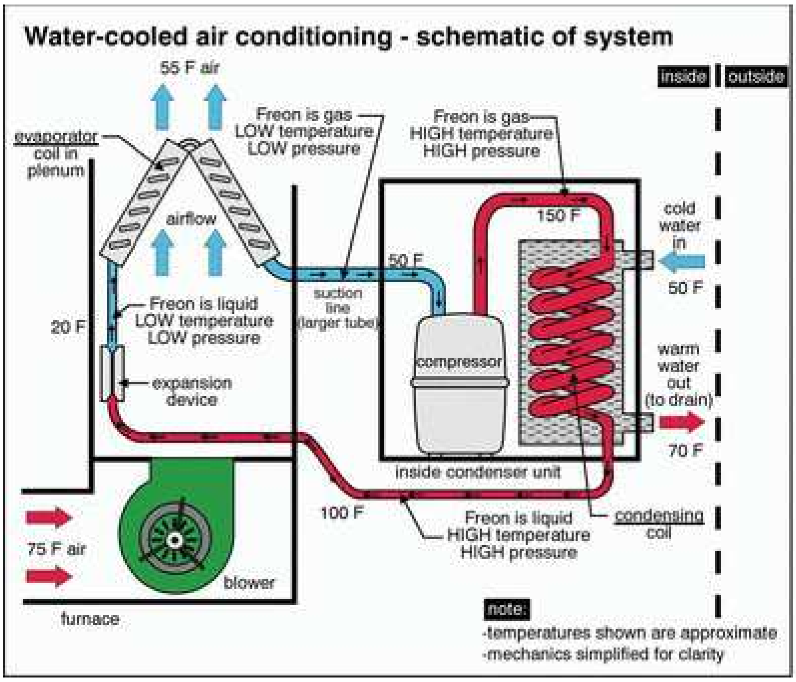
Cooling systems that are found in both residential and commercial settings are conditioners. There were two main primary functionalities among air conditioners: (i) to maintain air temperature inside a room (cooling *and* heating) and (ii) to maintain air temperature inside a room (cooling only) leading to two distinct categories (reversible air conditioners and cooling only air conditioners) *(Armines, 2008).* Contrary to cooling systems in industrial settings, cooling systems in residential and commercial buildings are used for comfort instead of process applications. Comfort applications aim to provide an indoor temperature that remains relatively constant in a range preferred by humans.

There are three types of cooling systems technologies found in buildings that use water: water cooled, cooling towers, and evaporative coolers.

Water-cooled air conditioning systems (also referred to as mini chillers) work essentially in the same way as conventional systems which are air cooled. Water-cooled air conditioning systems use water (instead of air in air-cooled systems) as a chiller to remove heat from the high temperature gas in the compressor/condenser unit. Once the water has cooled the gas back down to a liquid, the warmed water must be disposed of and usually goes down a drain. Figure 16 below shows how the water-cooling process works. Nevertheless, cooling is not delivered directly to the air but via a water network that supplies water, by the intermediary of a water pump, to cooling floors or panels and fan coil units.

[25] At least one of the national figures in this EU aggregate is estimated

Figure 16: Water-cooled air conditioning system



Evaporative coolers, also called "swamp coolers" rely on the evaporation of water to cool building air, rather than the movement of a refrigerant through cooling coils. Cooling towers, swamp coolers, and even a simple window fan blowing air across a pan of water and into a room are types of evaporative cooling systems. Swamp coolers systems may use less energy than a refrigerant-gas and compressor type air conditioner but are limited by one major factor – humidity. The more humid the outdoor environment, the less effective they become.

For commercial buildings such as large office buildings, hospitals, and schools, one or more cooling towers are used as part of their air conditioning systems. Cooling towers are heat rejection devices used to transfer process waste heat to the atmosphere. Cooling towers may either use the evaporation of water to reject process heat and cool the working fluid to near the wet-bulb air temperature or rely solely on air to cool the working fluid to near the dry-bulb air temperature. Cooling towers found in commercial settings operate in the same way as cooling towers found in industrial processes except that they are used for comfort applications. Refer to the sub-section 3.2.3.1 pg. 116 on cooling equipment in industry for further information. There is little research on how people occupying air-conditioned dwellings actually use their units. However, future levels of ownership of air conditioning in dwellings will depend on such factors as market penetration, price, and the severity of summers.

- **Potential for improvement**

Evaporative coolers are increasingly being considered as a clean and green alternative for cooling homes, especially in countries such as Australia. Evaporative coolers provide a number of benefits over refrigerated air conditioners, including lower capital costs, less energy costs, no refrigerant requirements, and increased comfort in drier areas due to the higher humidity provided compared to the dry air of refrigerated units *(Sean MacGown, 2009)*. Next generation evaporative coolers currently under development are expected to include controllers enabling the motor to operate at high efficiency at all flow rates.

Regardless of the cooling system used in the building, there are several things users can do to decrease water use in general. Some include:

- Install a thermostat and timer on your cooler so it only operates when necessary.
- Use a two-speed blow motor. Operating at low-speed uses less water and is more energy efficient.
- Inspect your cooler monthly and perform maintenance as necessary to be sure that your cooler is operating efficiently.
- Use alternative methods of cooling, including ceiling fans or keeping air circulated in rooms by leaving windows open

➢ **Market trends**

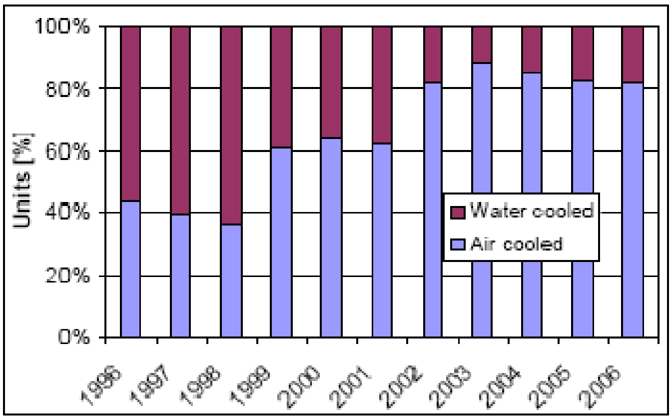
Air conditioners are often bought as an 'impulse purchase', meaning that most consumers only think about purchasing an air conditioner when they face sudden heat waves. As a result, sales vary widely through the year, by geographical area, and by year based on climate, therefore it is difficult to make general market trends at the EU level. Nevertheless, market research uncovered some data for water-cooled air conditioners.

There currently exists no PRODCOM classification for evaporative coolers, thus market trends at the EU level for this WuP is not available from Eurostat. Therefore, no market data has been identified or supplied by stakeholders at the moment for Europe. On the other hand, evaporators as a separate product are likely to have very low environmental impact because of supposed small market shares *(Armines, 2008)*.

For water-cooled air conditioners, data shows that their production is decreasing, and Figure 17 illustrates this trend. The fact that water-cooled units require either a water loop (which is difficult to install and implement) and imply important water consumption levels seem to explain this trend *(Armines, 2008)*. To date, data shows that water-using cooling systems used in buildings have a lower penetration rate compared to air-cooled cooling systems.

As for cooling towers found in commercial buildings, recent market research shows that the market for cooling towers is saturated, with little scope for technological innovations. Customer preference for air-cooled products is also expected to affect the market for packaged cooling towers (*PR WEB, 2008*).

Figure 17: Non moveable air conditioners, share of water cooled and air cooled package air conditioners (Cooling capacity < 12 kW) in number of models *(Armines, 2008)*



3.1.3.17 Summary of market trends for residential and commercial WuPs

WuPs found in residential and commercial buildings include a diverse range of products and market trends. An understanding of market trends is important to anticipate if a particular WuP will continue to have a significance presence in the market in the future. Several different data sources were used to find product market information to enable the widest range of data interpretation and analysis possible.

➢ **PRODCOM data**

The PRODCOM statistics have the advantage of being the official EU-source that is also used and referenced in other EU policy documents regarding trade and economic policy, thus guaranteeing EU consistency. PRODCOM data are based on products whose definitions are standardised across the European community and thus allow comparability between member country data. PRODCOM classifies WuPs used in buildings in a wide range of NACE codes. The NACE code system is the European standard for industry classifications. It assigns a unique 5 or 6 digit code to each industry sector. For the WuPs that have been identified, NACE categories include NACE 29.71 "manufacture of electric domestic appliances", NACE 29.54 "manufacture of machinery for textile, apparel and leather production", NACE 29.13 "manufacture of taps and valves", NACE 25.23 "manufacture of builders ware of plastic" and NACE 26.22 "manufacture of ceramic sanitary fixtures". These categories include a large range of products, though certain WuPs in buildings explicitly appear in this classification. For example, the product category "plastic toilet parts" is included because other products such as plastic lavatory pans, flushing cisterns and similar sanitary ware are also taken into account in the product data. In the context of this study, the flushing cistern is what interests us the most as it is the mechanism of the toilet that controls flushing and therefore water consumption. Although the product categories "ceramic sinks, wash basins, and baths and plastic baths, shower-baths, sinks, and wash basins", do not specify whether the products include taps (the component responsible for water usage), it gives an overall idea of the extent that these products are being produced and traded.

Because few criteria are used to identify the different types of products, PRODCOM data will need to be supplemented by other sources of economic data. For many of the WuPs used in buildings, PRODCOM does not distinguish between those used in residential or commercial buildings. For example, for washing machines, several different PRODCOM categories exist for this product and no clear separation was made between domestic and non-domestic washing machines. In fact, PRODCOM lists washing machines as being either residential or laundry-type (which most likely refers to the commercial machines in laundromats). Thus, in the tables below, data for washing machines include both residential and commercial type washing machines. For certain products such as for dishwashers, PRODCOM specifically lists residential and non-residential dishwashers separately. For illustration, Table 25 lists WuPs used in the building sector according to PRODCOM. Table 26 shows import and export quantities and Table 27 shows production information for residential WuPs issued from PRODCOM data. Finally, Table 28 shows the percentage of change from 2004 to 2007 in production quantities. The time period shows data from 2004 to 2007 for EU27 totals.

Table 25: WuPs as classified by PRODOM

WuPs in buildings	NACE category & description		PRODCOM code & description	
Residential dishwashers	29.71	Manufacture of electric domestic appliances	29.71.12.00	Household dishwashing machines
Non-residential dishwashers	29.24	Manufacture of other general purpose machinery	29.24.60.00	Non-domestic dish-washing machines
Washing machines (for both residential & commercial)	29.54	Manufacture of machinery for textile, apparel and leather production	29.54.22.30	Household or laundry-type washing machines of a dry linen capacity > 10 kg
	29.71	Manufacture of electric domestic appliances	29.71.13.30	Fully-automatic washing machines of a dry linen capacity <= 10 kg
Taps	29.13	Manufacture of taps and valves	29.13.12.35	Taps, cocks and valves for sinks, wash basins, bidets, water cisterns, etc
	25.23	Manufacture of builders ware of plastic	25.23.12.50	Plastic baths; shower-baths, sinks and wash basins
	26.22	Manufacture of ceramic sanitary fixtures	26.22.10.50	Includes ceramic sinks, wash basins, baths... and other sanitary fixtures
Toilets	25.23	Manufacture of builders ware of plastic	25.23.12.90	Plastic lavatory pans, flushing cisterns and similar sanitary ware (excluding baths; shower-baths, sinks, and wash-basins, lavatory seats and covers

WuPs in buildings	NACE category & description		PRODCOM code & description	
Cooling systems[26]	29.23	Manufacture of nondomestic cooling and ventilation equipment	29.23.12.20	Window or wall air conditioning systems, self-contained or split-systems
Outdoor WuPs[27]	29.32	Manufacture of other agricultural and forestry machinery	29.32.40.10	Agricultural or horticultural watering appliances

Table 26: Export and Import quantities from 2004-2007 for WuPs in buildings as classified under PRODCOM[28]

WuPs in buildings	Unit	2004		2005		2006		2007	
		Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Residential dishwasher	p/st[29]	2 044 776	489 621	1 442 611	755 591	1 604 657	1 359 928	1 577 795	1 763 538
Non-residential dishwasher	p/st	91 130	8 381	102 480	12 808	74 659	15 831	100 778	20 587
Residential and non-residential washing machines	p/st	5 729 090	2 001 178	6 536 147	2 581 660	6 063 041	3 304 148	6 004 043	3 467 022
Taps	kg	19 035 200	30 516 700	19 365 500	32 495 300	20 015 900	35 542 600	19 939 800	34 893 700

Table 27: Production quantities from 2004-2007 for WuPs in buildings as classified under PRODOM

Water-using product	Unit	2004	2005	2006	2007
Residential dishwasher	p/st	8 968 445	9 178 301	9 887 949	9 614 846
Non-residential dishwasher	p/st	329 895	346 280	343 999	373 219
Residential and non-residential washing machines > 10kg	p/st	17 352 898	17 980 971	18 124 136	18 296 193
Taps (kitchen wash basin)	kg	275 834 800	245 700 203	210 000 000	280 000 000
Plastic toilet parts	p/st	115 795 300	108 793 017	139 451 979	149 048 393
Ceramic sinks, wash basins,	p/st	10 836 231	10 073 330	9 625 534	10 814 016

[26] Air conditioners are only covered by this NACE Code. They do not fall under the list of electric domestic appliances (NACE 29.71), not even movable air conditioners. Both air cooled and water-cooled air conditioners seem to be included in this classification.

[27] Please note that PRODCOM definition does not distinguish between the different types of watering appliances, therefore it is uncertain the exact products statistics will contain.

[28] Please note that import and export information from PRODCOM was not available for toilets, cooling systems, and outdoor WuPs.

[29] p/st = pieces/sticks

Water-using product	Unit	2004	2005	2006	2007
baths					
Plastic baths, shower-baths, sinks, wash basins	p/st	13 072 442	17 143 356	20 327 170	18 325 016
Cooling systems[33]	p/st	1 592 045	1 864 338	2 814 190	2 984 055
Outdoor WuPs	p/st	5 600 000	4 889 810	9 402 636	9 233 193

Table 28: Percentage of change from 2004 to 2007 in production quantities of WuPs in buildings

Residential water-using product	% of change (- or +)
Residential dishwasher	+ 7%
Non-residential dishwasher	+ 13.13%
Residential and non-residential washing machines	+11.2%
Taps (kitchen wash basin) in kg	+ 1.5%
Plastic toilet parts	+ 29%
Ceramic sinks, wash basins, baths	- 0.2%
Plastic baths, shower-baths, sinks, wash basins	+ 40%
Cooling systems	+46%
Outdoor WuPs	+39%

According to PRODCOM product classification and data, almost all products that were identified as a WuP in the building sector show increasing production rates, with the exception of ceramic sinks, wash basins, and baths, which show a slight decrease of 0.2%. This does not necessarily mean that there is a decreased production of taps, but perhaps just a decreasing number of ceramic products associated with taps (e.g. sinks and wash basins). Furthermore, it should be noted that for cooling systems and outdoor WuPs, data is extremely uncertain because the PRODCOM classification does not distinguish between individual products within the product category. Therefore, it is difficult to say whether these figures correspond to water-using cooling systems and outdoor WuPs that have been identified in the building sector.

- **MTP (United Kingdom) data**

According to studies conducted by the MTP, the demand for additional housing, in line with changing demographic factors including a higher proportion of single person households, will influence growth in the market of residential WuPs. The increasing number of households has a direct impact on the number of WuPs being sold, installed, and used across the EU. Emphasis on emerging designs and styles has also driven refurbishment projects and increased the replacement rate of kitchens and bathrooms. In addition, many homes are having en-suite and additional facilities installed. However, the significant cost of replacing a bathroom or kitchen means that the purchase is more likely to be deferred during times of economic uncertainty (*Market Transformation Program (6) 2008*).

3.1.3.18 Overview of the use behaviour and market trends

The following table summarises the information already presented in previous sub-sections.

Table 29: Summary of the use, market trends and potential for improvement of some WuPs

WuPs category	Use patterns (key parameters)	Potential for improvement	Market trends
Residential buildings			
Toilets	- Flush volume - Nb flush/pers/day	Dual flush	→ (replacement cycle of 15 years)
Taps	- Flow rate - Nb use/household/day	Aerators, sensors	→
Showerheads	- Flow rate - nb use/household/day	Aerating, laminar showerheads	→
Baths	- bath capacity - nb use/household/day	Reduced volume	→
Washing machines	- litre/cycle - nb cycle/week	Intelligent function (load detectors...)	→(10 years lifespan)
Dishwashers	- litre/cycle - nb cycle/week	Intelligent function (load detectors...)	↗(10 years lifespan)
Outdoor WuPs	- climatic conditions	Sensors (moisture sensors for instance)	↗(according to PRODCOM)
Commercial Buildings			
Urinals	- Flush volume - Nb flush/pers/8 hrs shift	Low flush and flush control	.
Taps	- Flow rate	Spray taps, sensors, timed turn-off taps	.
Toilets	- Flush volume - Nb flush/pers/8 hrs shift	Idem residential	.
Ice makers	.	Intelligent control	.
Washing machines/ laundries	- litre/cycle	Waste water recycling	.
Dishwashers	- litre/cycle	Improve overall energy efficiency	.
Outdoor uses	Idem residential	Idem residential	.
Car washes	- litre/car wash	Water reclaim Waterless washing	↗
Industrial			
Cooling towers	.	Water recycling Blow-down management	↘
Boilers	.	Blow-down management	↘
Pressure Washers	- Flow rate	Increased pressure Increased temperature	.
Steam Cleaners	- Flow rate	Increased pressure	.

WuPs category	Use patterns (key parameters)	Potential for improvement	Market trends
		Increased temperature	
Scrubber driers	- Flow rate	Detergent concentration	.

3.1.4. WATER PERFORMANCE ASSESSMENT OF WUPS IN BUILDINGS

The approaches to assess the water use efficiency of domestic WuPs fall into the categories presented in Box 1 below.

When designing field-based performance assessments, the larger the sample size the more accurately the results will reflect the behaviour of the wider population and for this reason, sample size becomes an important issue. In general, the confidence interval that can be applied to the results is inversely proportional to the square root of the sample size. As a rule, to get within +/- 5% the confidence interval requires a sample size of around 400 to 500 households.

Where possible, the case studies used in the following sub-sections on WuPs are based on studies with large sample sizes.

Box 1: WuPs performance assessment approaches in residential buildings

- Large-scale projects: these range from self-audits in which water efficient fitting are installed by the householder, to visit-and-fix projects in which installation of fittings is done by the water company. Results can then be measured based on changes in the metered household water consumption.
- Component studies: these examine one particular type of WuP, e.g. showers, WCs, faucets, etc. Data collection in such studies historically requires special meters, known as data-loggers, to be fitted to the specific appliance which can be somewhat intrusive. More recently though, meters have been developed that can be calibrated to sense the flow signal or pattern of a specific WuP, e.g. in the Identiflow study (WRc, 2006) reported below, and these can be fitted to the supply pipe so are less intrusive.
- Other studies: such as community projects or those that focus on metering, leakage, new homes, tariffs, etc, may rely on single households, i.e. revenue, meters, sub-meters on multi-unit blocks, or meter reading at the boundary of district metering zones.

3.1.4.1 Residential toilets

➢ **Standard product**

Residential water consumption by toilets, or WC, is determined by the WC's flush volume, whether the WC is leaking, and the frequency of use, usually determined by the number of occupants. Of the appliances that use water in a house, the WC uses the most; about 30–40% of domestic water use. Therefore, optimising the water used by toilets can make the greatest savings.

The main factor affecting the amount of water used by households for toilets is flush volume. The actual flush volumes of installed WCs depend on two factors: the installation and performance of toilets and user behaviour. An effective flush volume is the volume of water needed to clear the toilet pan and transport solids far enough to avoid blocking the drain.

Generally, the age of the toilet dictates the maximum allowable stored volume of the cistern. Table 30 below provides examples for two MS.

Table 30: Estimated flush volumes for WCs given the year of installation

Year	United Kingdom	Finland
Prior to 1976	9+ l/flush	9 l/flush
1976-1989	9+ l/flush	6 l/flush
1989-1993	7.5-9.5 litres dual flush	4 l/flush
1993-2000	7.5 l/flush	2-4 litres
After 2001	6 l/flush	2-4 litres

Results of empirical studies of WC usage for four European countries are presented in Table 31. The results from the European studies are compared with a representative study from the USA.

Table 31: Summary of water consumption and frequency of use for toilet flushing

Country	Average water consumption per flush (litres)	Frequency of toilet flushing (per day)	Average total water consumption per day (litres)	Data source
England	9.4	11.62	109.2	*WRc, 2005*
Bulgaria	9.5	12.5	118.8	*Dimitrov, 2004*
Portugal	9.1	9.3	84.8	*Viera et al., 2007*
Finland	6.0	-	-	*Etelmaki, 1999*
Range (Europe)	**6.0 – 9.5**	**7 - 11.62**	**84.8 – 118.8**	*Etelmaki, 1999*
USA	13.7	12.97	177.7	*Mayer et al., 2000*

➢ **Water-efficient alternatives**

Table 32 below presents results from experiments with water efficient WCs, and expected consumption ranges.

Table 32: Results of WC trials

WC Type	Expected average volume/flush	Actual average volume/flush	Notes	Trial name
4/2 litres dual-valve	2.4 litres	4.6 litres (3.1-6.1)	Sticking mechanism not identified during trial	Holmewood (Bradford)
6/3 dual-valve	3.6 litres	4.6 litres (3.7-5.4)	Sticking mechanism not identified during	Holmewood (Bradford)

WC Type	Expected average volume/flush	Actual average volume/flush	Notes	Trial name
			trial	
4/2 litre dual valve	2.4 litres	3.83	5 years trial, valve jammed twice	Portsmouth Water Co.
6/3 litres dual-valve	3.6 litres	6.1 litres	Women's WCs only	Portsmouth Water Co.
6/3 litres dual-valve	3.6 litres	8.6 male 6.5 female	Problems identified during analysis of data logger	Millennium Dome Water Cycle Experiment
6/3 litres dual-valve	3.6 litres	5.4 male 5.1 female	Jamming mechanism fixed	Millennium Dome Water Cycle Experiment
6 litres single siphon flush *initial*	6 litres	6.2 male 5.2 female		Millennium Dome Water Cycle Experiment
6 litres single siphon flush *after retrofit*	6 litres	5.5 male 5.5 female	Water levels adjusted	Millennium Dome Water Cycle Experiment

A review of the current literature shows that, with good pan design, full flush volumes down to 4 litres do not present a problem in terms of 'normal' drains and sewers being able to dispose of the solid and liquid wastes (*Lillywhite, 1987*). This can be achieved with a leak-free siphon. For example, recent studies in the United Kingdom (*Waterwise (1), 2008*) have involved WCs imported from Sweden and led to the development of the Ifö Cera ES4, a 4 litre siphon-flush suite, initially as a stopgap to meet the United Kingdom's old Water Byelaws. Commentators have said that, if the siphon does go out of fashion then it would be possible to look forward to significant water wastage in the future from leaking toilets. Technical solutions to problems such as button-operated siphons or leak-detecting valves are possible, but seem unlikely to happen unless driven by regulations and (independent) water-use labelling schemes (*Grant et al.,1999*).

Other WCs are available with a 4 and 2 litre dual flush, and this should theoretically beat a 4-litre single flush WC, but as the studies in Table 32 (above) indicate, this is not guaranteed and for public toilets and commercial buildings single flush would be more recommendable to use single flush rather than this type of low volume dual flush.

The information in the above table only provides a limited picture of the potential for improvement. Figure 18 and Figure 19 (below) were developed from data collected in a study (*WRc, 2005*) of 449 households carried out in 2002 in Southern England and show the spread of flush-volumes of WCs and the number of flushes per day in households with different occupancies. The example provides results that can be applied to the wider population with ±5% confidence limits. For example, using the average flush-volume and average flush frequency in Figure 18 and Figure 19, if 4-litre siphon flush WCs were installed in 30% of houses in the sample, assuming an average saving per flush of 5.4 litres, i.e. 9.4 - 4, the water manager could expect a daily saving of 62.7 litres per household or 22.88 m^3 per household per year. However, if all WCs with a flush volume of, say, 7.5 litres or over (average flush volume = 10 litres) were changed to efficient 4-litre models the savings would be 25.4 m^3 per household per year. These savings correspond to recorded savings from installing dual-flush WCs. For all of London, assuming a penetration rate of 60%, this equates to potential water savings of 50,800 million litres (ML) per year.

Apart from the obvious reductions in water abstractions, this would also result in significant energy savings. On average, 1M L of water requires 468 kWh to supply it, producing 209 kg of CO_2, while 1M L of wastewater requires 437 kWh to be treated, producing 195 kg of CO_2 (*Building Research Establishment, 2004*). These values will vary depending on the source of water and the amount of pumping and treatment involved.

The data on flush frequencies in different occupancy households in Figure 18 show that WCs in single occupancy households are only flushed on average 7 times per day, but in 2-6 occupancy households, they are flushed 11-14 times per day, indicating that the total water use over the WC's lifetime, and therefore the potential saving, would be significantly higher in higher occupancy households. A study in Sofia, Bulgaria (*Dimitrov (1), 2004*) has showed that household occupancy can have a significant impact on the economic efficiency of water efficient WCs. Figure 20 shows the payback period calculated for replacing 9 litre-flush WCs with 3/6 litre dual-flush WCs, based on different occupancies and per unit water prices.

Figure 18: WCs water use assessment example: Flush-volumes of WCs in 449 households (*WRc, 2005*)

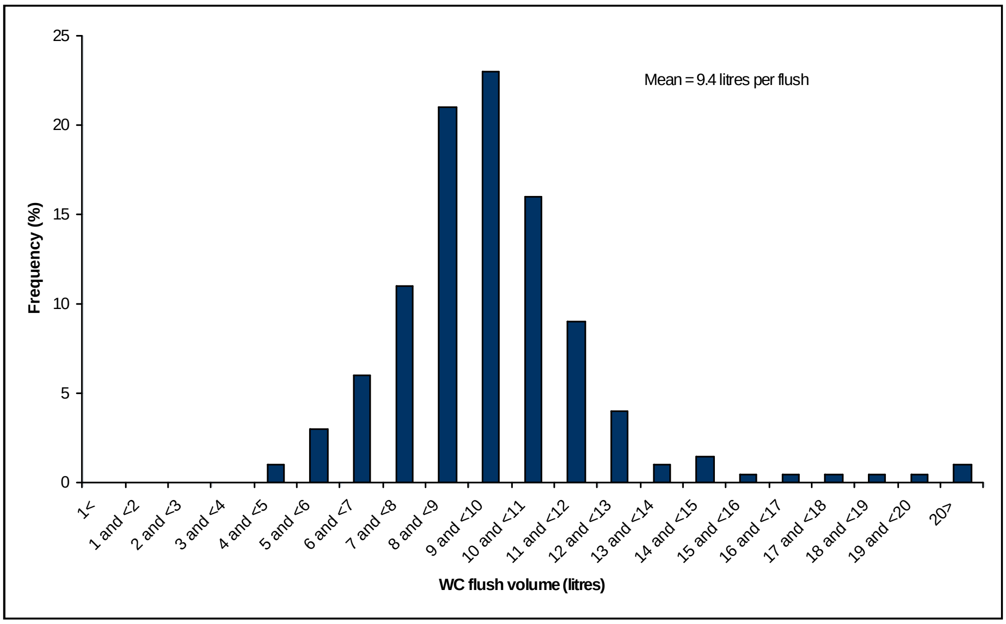


Figure 19: Water use assessment example: Frequency of use by occupancy (*WRc, 2005*)

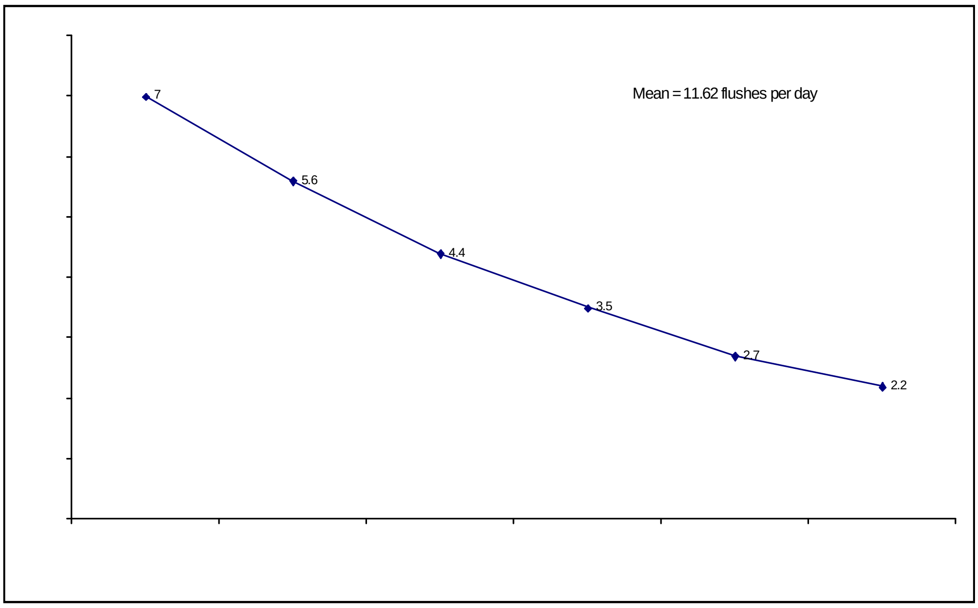
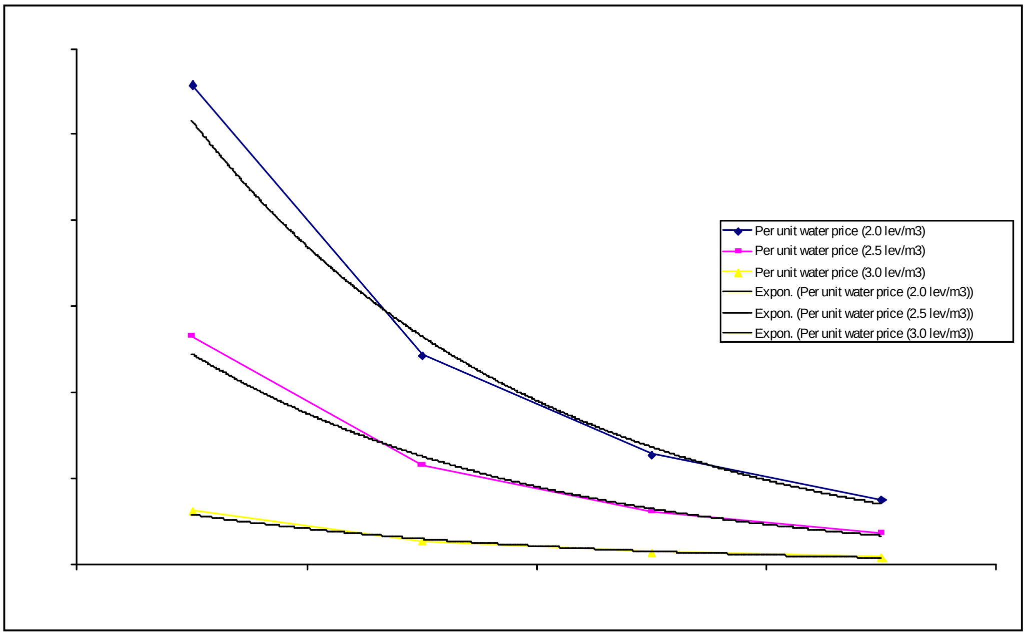


Figure 20: Economic assessment example: variable payback period for WCs, based on changing occupancy and per unit water price (*Dimitrov (1), 2004*)



Because most water conservation programmes involve a combination of measures, usually including showers, WCs, leakage checks and tap aerators, it can be difficult to confidently associate savings with a specific appliance. Table 33 reports disaggregated savings from 21 recent WC replacement programmes in the United Kingdom.

Table 33: Water savings assessment example: Results from WC replacement programmes in the United Kingdom between 1997 and 2008 (*Waterwise (1), 2008*)

Company	Project	Year	Cistern displacement device	Dual-flush toilets	Dudley turbo	ecoBETA dual-flush retro-fit device	Ecoflush retro-fit device	Variflush retrofit device
ESW	Moulsham	1997	25.00	-	-	-	-	-
ESW	Chelmsford-retrofit	2005	11.07	-	22.14	-	22.14	22.14
ESW	Chelmsford-full	2005	6.66	-	-	-	-	-
ESW	Brentford	2004	9.44	-	-	-	-	-
ESW	Romford	2004	10.80	-	-	-	-	-
ESW	Toolkit	2006/07	17.46	-	23.98	-	-	23.98
SWW	Multi-measure	2005/06	2.10	-	4.19	-	-	-
SWW	Single-measure	2005/06	0.01	-	24.39	-	-	-
TW	Liquid assets	2006	10.97	-	-	10.97	-	-
EA	Variable flush	2003/2004	-	-	-	-	16.90	24.00
ESW	Witham	2002	3.77	-	-	-	-	-
ESW	Thurrock	2006/07	12.89	-	-	-	-	-
ESW	H2eco	2007/08	10.35	-	-	10.48	-	-
ESW	ecoBETA	2007	-	-	-	31.38	-	-
SES	Preston-retrofit	2007/08	-	145.29	-	53.49	-	-
SES	Preston-refurb	2007/08	-	61.32	-	-	-	-
UU	Showerhead offer	2007	-	-	-	-	-	-
UU	Home audits	2006/07	34.60	-	-	34.60	-	-
YOR	Water Saving Trial	2007/08	5.73	-	11.46	5.73	-	-
STW	Water Efficiency Trial	2007/08	11.22	-	11.22	11.22	-	-
ANG	Water Efficiency Audit	2007	11.38	-	-	11.38	-	-
Number of projects included in assessment			16	2	6	8	2	3
Savings range for assessment (l/prop/day)			0.01-34.60	61.32-145.29	4.19-24.39	5.73-53.49	16.90-22.14	22.14-24.00

ANG = Anglian Water; SES = Sutton & East Surrey Water; TW = Thames Water; ESW = Essex & Suffolk Water; STW = Severn Trent Water; UU = United Utilities; EA = Environment Agency; SWW = South West Water; YOR = Yorkshire Water

3.1.4.2 Residential taps (kitchen and washbasin taps)

➢ **Standard product**

The water consumption of taps, which include kitchen and bathroom taps, is dependent upon the flow rate of the fitted device, the time per use, and the frequency of use. When assessing the performance of a tap, an initial check of each tap should take place and dripping taps should have their washers replaced by the surveyor.

Excessive flows and/or leaks from taps in bathrooms and kitchens can be a significant source of water wastage. A single dripping tap can waste more than 24 000 litres per year (*Department for Natural Resources, Mines and Water, 2006*). Unregulated flows can reach 15-20 l/min when 6 l/min or even less is enough for hand washing. Reducing flows from hot water taps has the added benefit of saving energy. Such savings typically exceed the water cost savings by 2 or 3 to one.

A review of existing reports identified that there have been very few examples of faucet monitoring studies in households in EU MS.

The graphs in Figure 21 and Figure 22 below, shows the volume per use and the uses per day of taps in different occupancy households in England (*WRc, 2005*).

Figure 21: Water volume per use, taps (*WRc, 2005*)

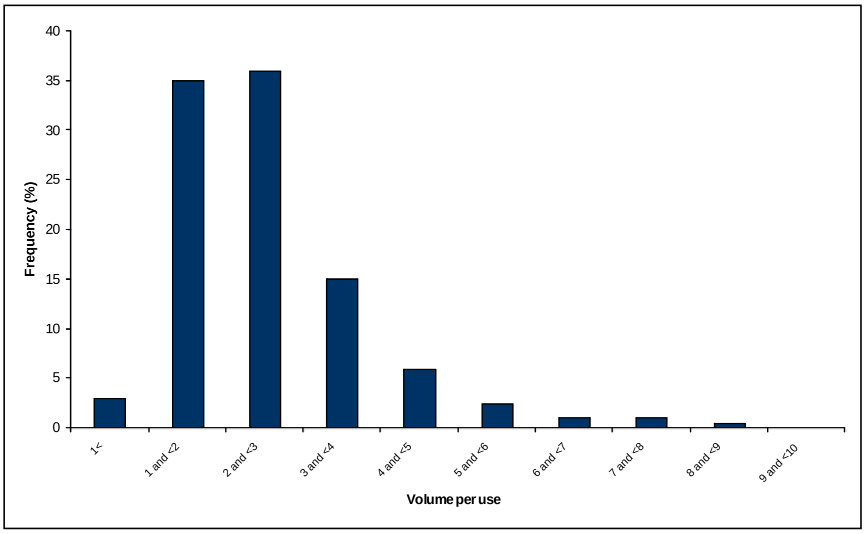
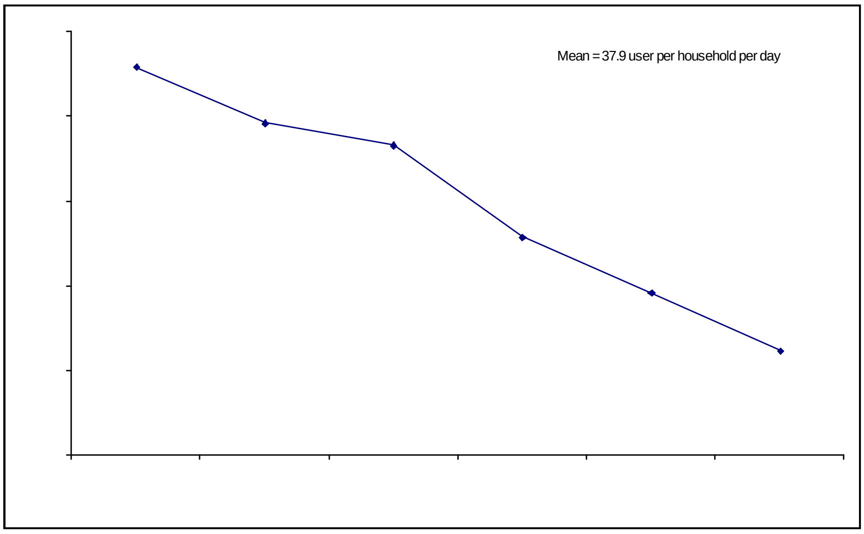


Figure 22: Frequency of tap use for different occupancy households (*WRc, 2005*)



The results in Table 34 below are from empirical studies. Anecdotal evidence (*Alitchkov, 1996*), however, indicates that consumption for taps may be up to 50% higher in other EU countries.

Table 34: Summary of faucet usage in EU MS

Country	Average water consumption per use (litres)	Frequency of use (use/household/day)	Average total water use per day (litres/household/day)	Data source
England	2.3	37.9	87.2	*WRc, 2006*
Portugal	5.84	10.6	61.9	*Viera et al., 2007*

Water-efficient alternatives

Some very simple and inexpensive retrofit measures are available for existing devices that save water as well as energy whilst improving user amenity and safety. Savings of 20-30% are common with paybacks of less than 2 years. A range of measures is summarised below:

- Fit new water efficient tap-ware. New low-flow and aerating models may use as little as 2 l/min, depending on the intended application.
- Fit low flow aerators to basin spouts which may reduce the flow to less than a third (6 l/min or less). This is an inexpensive option but devices are subject to clogging and tampering.
- Fit long life tap washers (usually with a rubber O-ring and mechanical protection against over tightening) as insurance against future unreported leaks and to reduce maintenance costs. This should be done in conjunction with almost all the above measure (*Vickers, 2001; Sydney Water and Clubs NSW, 2008; Sydney Water, 2001*).

Results from recent programmes in the United Kingdom involving maintenance or replacement of existing faucets with water saving technology are presented in Table 35 below.

Table 35: Results from faucet maintenance and replacement programmes in the United Kingdom between 1997 and 2008 (*Waterwise (1), 2008*).

Company	Project	Year	Tap inserts and restrictor	Tap washers	Turning the tap off when brushing teeth
ESW	Moulsham	1997	-	5.25	-
ESW	Brentford	2004	-	9.90	26.73
ESW	Romford	2004	-	13.08	29.75
ESW	Toolkit	2006/07	11.83	-	-
SWW	Multi-measure	2005/06	2.07	-	-
SWW	Single-measure	2005/06	24.89	-	-
TW	Liquid assets	2006	10.82	-	-
ESW	Witham	2002	3.77	-	19.41
ESW	Thurrock	2006/07	-	0.47	10.31
ESW	H2eco	2007/08	10.35	9.01	-
YOR	Water Saving Trial	2007/08	5.66	-	-
STW	Water Efficiency Trial	2007/08	11.07	-	-

Company	Project	Year	Tap inserts and restrictor	Tap washers	Turning the tap off when brushing teeth
ANG	Water Efficiency Audit	2007	11.23	-	-
Number of projects included in assessment			9	5	4
Savings range for assessment (l/prop/day)			2.07-24.89	0.47-13.07	10.31-29.75

ANG = Anglian Water; SES = Sutton & East Surrey Water; TW = Thames Water; ESW = Essex & Suffolk Water; STW = Severn Trent Water; UU = United Utilities; EA = Environment Agency; SWW = South West Water; YOR = Yorkshire Water

3.1.4.3 Residential showerheads

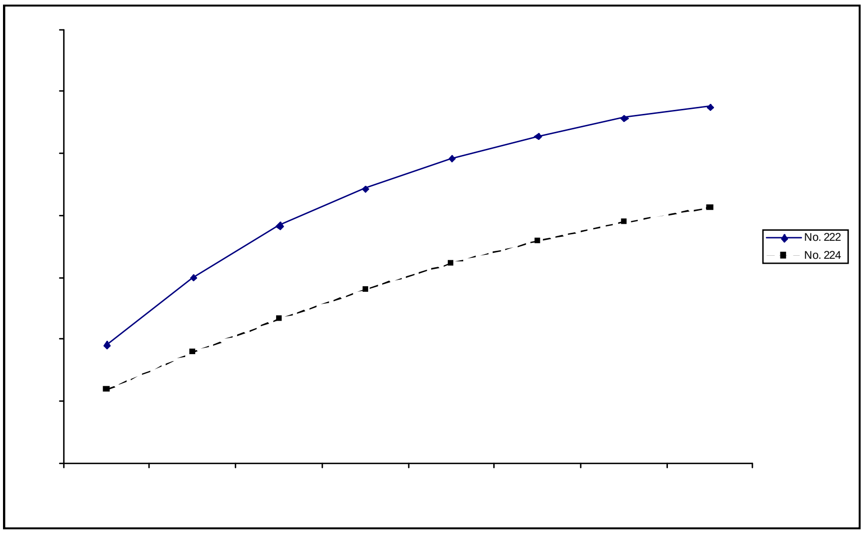
- **Standard product**

As was mentioned earlier, there are three main types of showers available: gravity-fed, electric and pumped. The water used by showers in residential buildings is determined by the type of shower already being used there, its flow rate, frequency of use and average time per use.

About 45% of households in the United Kingdom have an instantaneous electric shower (*Waterwise (2), 2008*) and because the volume of water that needs heating limits flow rates, these devices cannot be improved for water efficiency. The United Kingdom and Ireland are unique as far as electric showers are concerned. Most countries do not have electric showers or low pressure systems so shower water use is usually higher compared to the United Kingdom.

For gravity-fed showers, the graph in Figure 23 demonstrates the impact of pressure on shower flow rates.

Figure 23: Effects of system pressure on flow-rate of two types of self-mixing shower-heads (*Dimitrov (2) 2004*)



Results of empirical studies in EU MS are presented in Table 36. The results from the European studies are compared with a representative study from the USA by (*Mayer et al., 2000*).

Table 36: Summary of water consumption and frequency of use showerheads

Country	Flow rate (litres/minute)	Average shower duration (minutes)	Average frequency of use (use/household/day)	Average water consumption per use (l/shower)	Average total water consumption per day (l/household)	Data source
England*	11.78	2.2	1.46	25.7	37.5	*WRc, 2005*
Portugal	10	-	2.5	58.4	146	*Viera et al., 2007*
Finland	-	-	-	60.0	-	*Etelmaki, 1999*
Germany	-	-	-	30-50	-	*Etelmaki, 1999*
France	16	-	-	-	-	*Etelmaki, 1999*
United Kingdom**	10.8	5	1.43	54	77.22	*United Kingdom Environment Agency, 2007*
United Kingdom***	6	5	1.43	30	43	*United Kingdom Environment Agency, 2007*
Range (Europe)	**3.9 - 16**	**NA**	**0.75 - 2.5**	**25.7 - 60**	**37.5 - 146**	*United Kingdom Environment Agency, 2007*
USA	8.48	7.91	0.51	68.4	34.88	Mayer et al., 2000

*449 households

**non-efficient new-build

***water efficient new-build

Frequencies of shower flow rates in a study (*Critchley, 2007*) of 40 households and frequency of use from a study (*WRc, 2005*) of 449 households are shown in Figure 24 and Figure 25.

Figure 24: Flow-rates of showers in 40 households (*Critchley, 2007*)

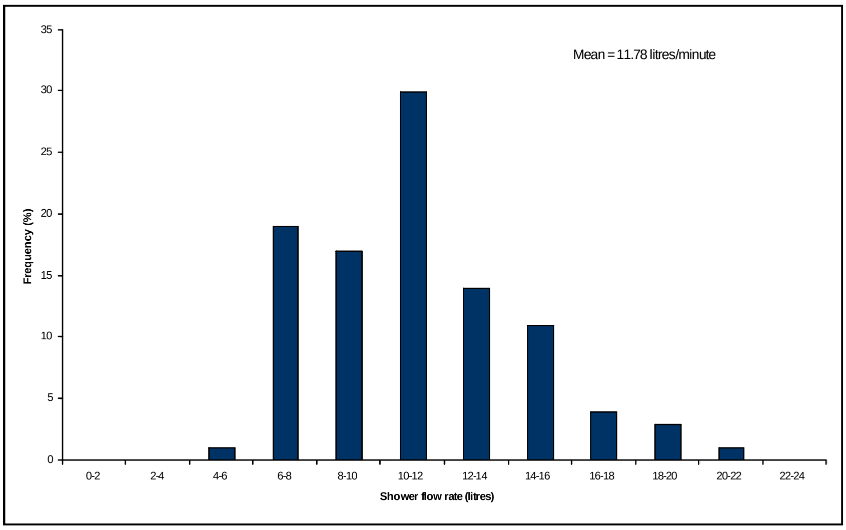
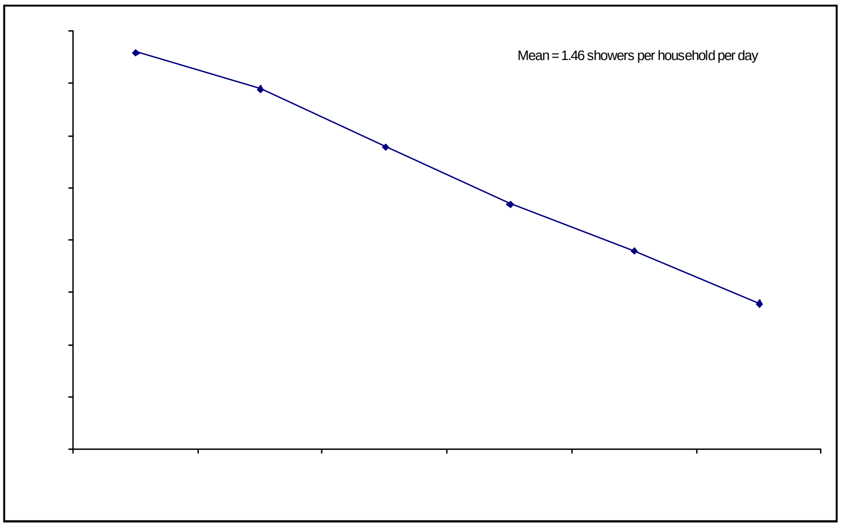


Figure 25: Shower frequency in households with different numbers of occupants (*WRc, 2005*)



➢ **Water-efficient alternatives**

Gravity-fed showers can have their flow rate reduced by using a flow restricting device or by using a low flow showerhead – these restrict the flow by altering the spray pattern or by introducing air into the showerhead. An aerated showerhead seems to provide the best solution as it appears to deliver a higher flow than it actually delivers and so provides the user with the experience of a power shower, but with significantly less water. However, aerated showerheads will not necessarily work on gravity fed systems and need a pressure of at least one bar to function correctly.

Non-gravity fed showers come in several different types, from instantaneous electric showers with average flow rates of around 4 to 6 l/min to pumped showers fed off hot water tanks that can deliver up to 30 l/min. Combo boilers and non-vented systems are becoming popular and these can deliver high flow rates to showers.

To help people limit showering durations, a shower timer can be used. These come in two types, either a sand timer set for a fixed duration or a digital alarm that the user can pre-set. As for limiting the frequency of showering it is not felt to be appropriate (unless switching from baths to showers) as this may be seen to be dictating lifestyles.

Table 37 below reports the results from 15 recent shower replacement programmes in the United Kingdom.

Table 37: Results from shower replacement programmes in the United Kingdom (1997-2008) (*Waterwise (1), 2008*)

Company	Project	Year	Shower timer	Shower-flow restrictor	Showerheads	Bath measure	Replace bathing with shower
ESW	Moulsham	1997	-	-	8.00	-	-
ESW	Brentford	2004	-	-	19.11	-	-
ESW	Romford	2004	-	-	22.36	-	-
ESW	Toolkit	2006/07	1.95	-	6.51	-	-
SWW	Multi-measure	2005/06	0.23	-	1.14	-	-
TW	Liquid assets	2006	1.23	-	5.95	-	-
ESW	Witham	2002	0.53	-	-	-	-
ESW	Thurrock	2006/07	26.05	-	-	-	37.31
ESW	H2eco	2007/08	-	-	5.69	4.44	-
SES	Preston-retrofit	2007/08	2.67	-	-	-	39.46
UU	Showerhead offer	2007	-	-	39.50	-	-
UU	Home audits	2006/07	-	-	18.77	-	-
YOR	Water Saving Trial	2007/08	0.64	-	3.11	-	-
STW	Water Efficiency Trial	2007/08	-	-	6.23	-	-
ANG	Water Efficiency Audit	2007	1.27	6.18	-	-	-
Number of projects included in assessment			8	1	11	1	2
Savings range for assessment (l/prop/day)			0.23-26.05	6.18	1.14-39.50	4.44	37.31-39.46

ANG = Anglian Water; SES = Sutton & East Surrey Water; TW = Thames Water; ESW = Essex & Suffolk Water; STW = Severn Trent Water; UU = United Utilities; EA = Environment Agency; SWW = South West Water; YOR = Yorkshire Water

- **Showers and energy use**

In addition to water use, showers are also widely known to be associated with high energy use, both for heating and pumping water. Customers with an existing mixer or pumped shower operating at over 8 l/min can enjoy a financial payback within a few months from installing a water saving showerhead that does not impair customer satisfaction. The available data was also used to estimate average annual water, energy and carbon use in the home for each method of personal washing, as presented in Table 38 below.

Table 38: Showers' impact on water and energy consumption of households

Type of shower	Flow-rate	Duration	Vol. per event	Energy per use	Cost to customer	Water use per household per year	Energy use per household per year	Total carbon use per household per year
Electric shower	3.9 l/min	5.8 min	22.6 l	0.95 kWh	£0.20	14,000 litres	580 kWh	249 kg
Mixer shower (short duration)	8 l/min	5.8 min	46.4 l	2.8 kWh	£0.26	28,000 litres	1,720 kWh	327 kg
Mixed shower (long duration)	8 l/min	9 min	72 l	4.3 kWh	£0.40	44,000 litres	2,650 kWh	503 kg
Pumped shower	12 l/min	9 min	108 l	6.5 kWh	£0.60	66,000 litres	3,980 kWh	756 kg
Bath	n/a	n/a	73 l	4.9 kWh	£0.43	35,000 litres	2,330 kWh	443 kg

The findings presented in Table 38 suggest that many mixer and pumped showers may consume more water, electricity and carbon than washing by bath. This is due to a combination of factors: water flow-rates of mixer and pumped showers can be significant, and the frequency and duration of showering are much greater than for bathing, particularly due to the ease of having a shower.

A further finding is that the energy use in homes to heat (and pump) water for personal washing is about 70 times than that used by a water company to supply the water and dispose of the wastewater. Therefore actions to reduce water use, and associated energy consumption by showers do not only reduce water abstraction from the environment but also, very importantly, will have a significant effect on the energy and carbon consumption in homes.

3.1.4.4 Residential baths

The main factors affecting the amount of water used per household for bathing are the type of bath and its capacity, and the usage pattern of the bath.

The size (volume and shape) of the bathtub and the level to which the user fills the tub also affect water use. Tapered or peanut-shaped baths may provide more space for bathing with less water. With the exception of whirlpool and jetted tubs, the size of standard bathtubs globally has generally decreased over time. Very few modern baths hold less than 130 litres, which is about 60 litres of water with a submerged adult. Some larger baths hold more than 300 litres, equivalent to the average volume of water two people use each day (*Waterwise (3), 2008*). Key existing bath product types are included in Table 39.

Table 39: Bath types, capacity to overflow and volume of water per usage, MTP modelling (*Market Transformation Program (4), 2008*)

Bath Type	Capacity to overflow (litres)	Usage (litres)
Undersized, 1, 600 mm primarily	165	65
Corner baths	140	65
Shower baths	250	100
Standard baths	225	88
Roll-top baths	205	80
Whirlpool/Spa baths	225	88
Large outdoor spa baths		1,500

3.1.4.5 Residential washing machines

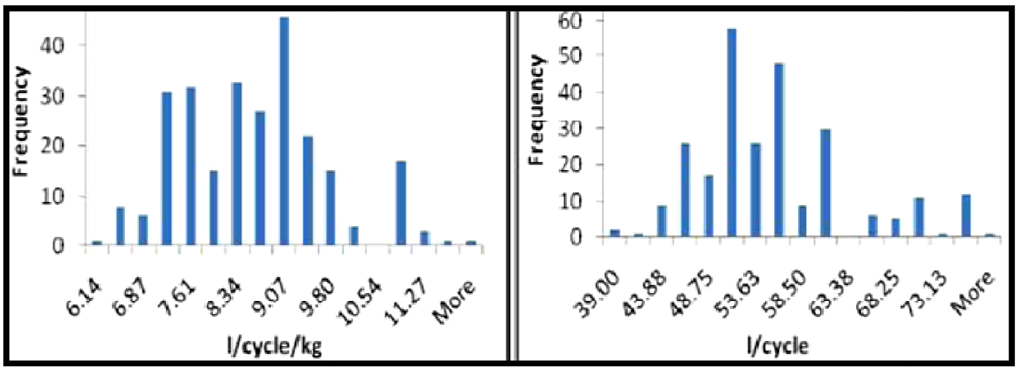
- **Standard product**

Efficiency of washing machines is measured either by the water volume used *per* cycle (l/cycle), or the volume used per kg or dry load (l/kg dry load).

A database (*Waterwise (4), 2008*) containing over 260 washing machine models that were available on the United Kingdom market in 2007, representative of over 25 brands, showed that wash capacities vary from 3 to 10 kilograms, with the most common loads being 5-6 kg. Mean water consumption for 6 kg machines was 50.20 l/cycle with a mean water efficiency index[38] of 8.37 l/cycle/load.

Mean water consumption overall was 54.08 l/cycle with a mean water efficiency index of 8.44 l/cycle/kg. Median water consumption was 53.00 l/cycle, and the median water efficiency index was 8.43 l/cycle/kg. Figure 26 illustrates the distributions of water consumption and efficiency in the United Kingdom (2007) database.

Figure 26: Distributions of water consumption and efficiency of washing machine models



Information on washing machine usage in households was collected from other European studies and is presented in Table 40 below.

[38] The water efficiency index was obtained by dividing total water consumption per cycle by wash capacity, to obtain litres consumed per kilogram (or place setting) washed.

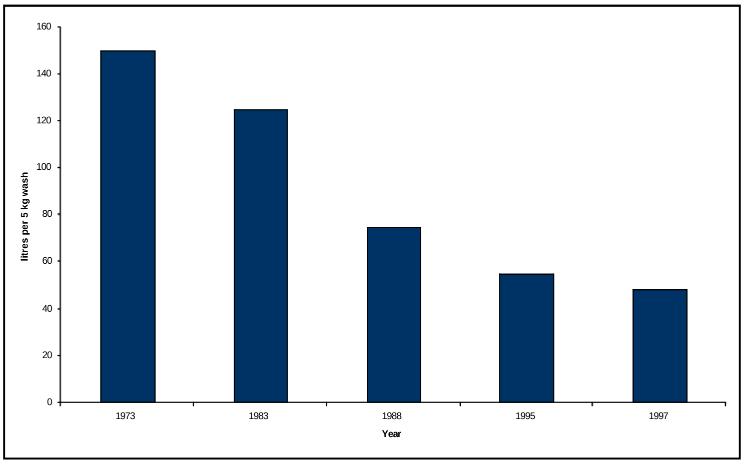
Table 40: Summary of water consumption and frequency of use of washing machines

Country	Average water consumption per cycle	Frequency of use (use/ household /day)	Average total water consumption per year or per day	Data source
United Kingdom	39-78	-	-	*Waterwise, 2008*
Portugal	82	0.6	82.6	*Viera et al., 2007*
England	61	0.81	48.8	*WRc, 2006*
France	75	-	-	*OFWAT, 1997*
Germany	72-90	-	-	*OFWAT, 1997*
England	80	-	-	*Etelmaki, 1999*
Finland	74-117	-	-	*Etelmaki, 1999*
Range (Europe)	**39-117**	**0.6-0.81**	**48.6-82.6**	**-**

- **Water-efficient alternatives**

Washing machines have become much more water efficient over the past twenty years. AEG provided figures of average water usage of their machines, which twenty years ago were about 150 l/cycle, whereas today these machines average about 50 l/cycle, with the most efficient machines using about 35 l/cycle. The water consumption of front-loading washing machines has been reduced by 76% since 1970, from 30 l/kg in 1970 to 13.6 l/kg in 1990 to 7.2 l/kg today. An example of the efficiency improvements of 5kg Bosch washing machines since 1973 is provided in Figure 27 below.

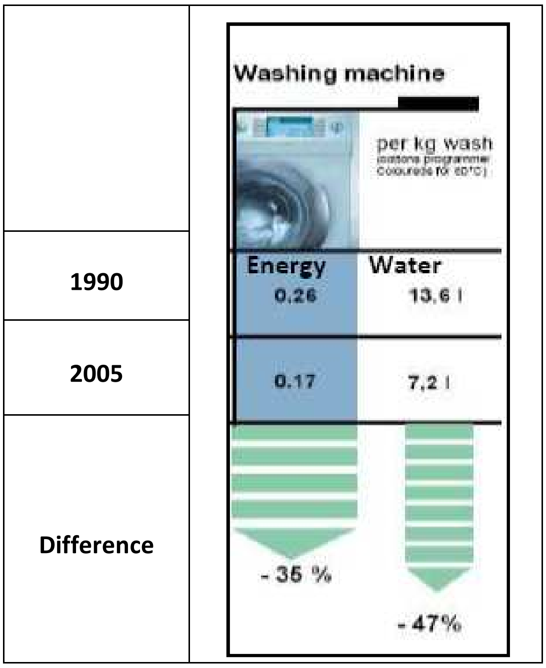
Figure 27: Water used by Bosch washing machines for 5kg hot wash – l/cycle (*Grant, 2002*)



- **Washing machines and energy use**

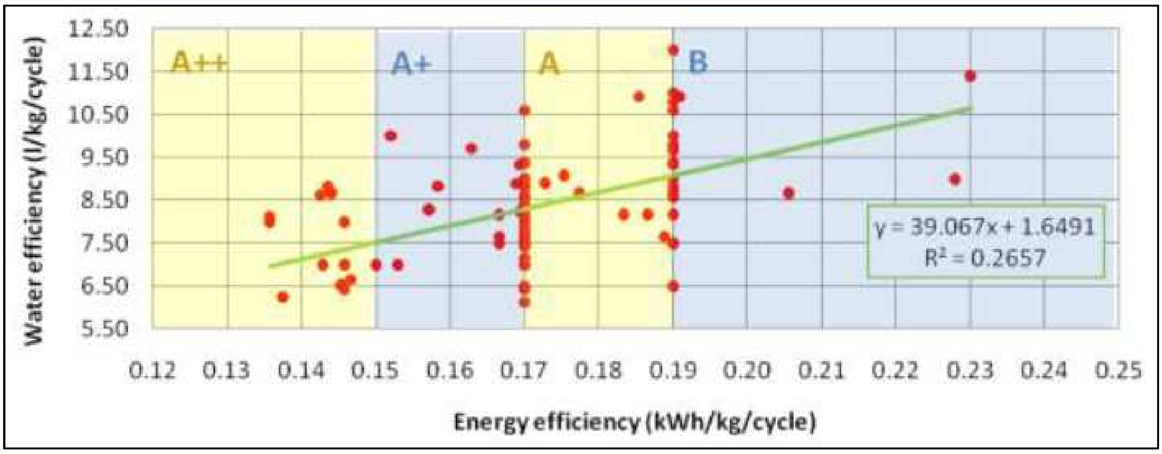
Water use in washing machines correlates to energy use. Figure 28 shows trends in energy and water consumption of Bosch und Siemens Hausgeräte appliances from 1990 to 2005.

Figure 28: Trends in energy and water consumption of Bosch und Siemens Hausgeräte appliances (*Otto, 2006*)



Comparison of *per* cycle water and energy use (Figure 29) in different models shows that there is a positive correlation between water and energy use (R^2 = 0.27).

Figure 29: Relationship between energy use and water use of washing machines adjusted for capacity (*Waterwise (4), 2008*)



3.1.4.6 Residential dishwashers

Similar to clothes washing machines, cycle times and frequency of use of the washing machine for a load of laundry will also determine water consumption levels.

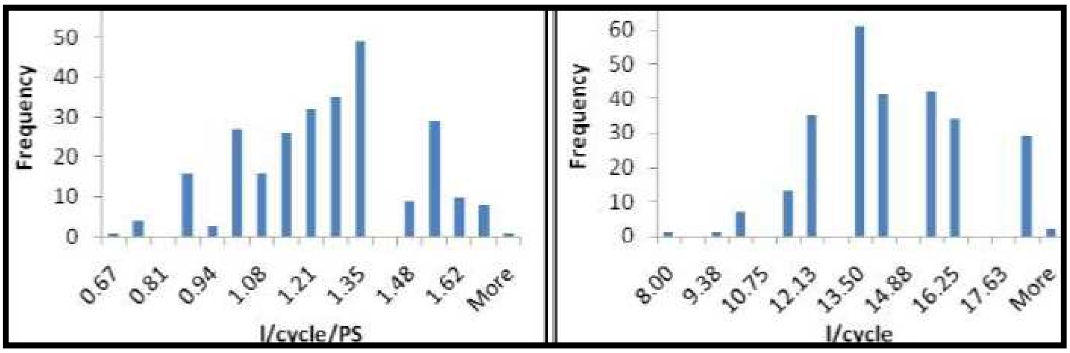
In general, the use of a dishwasher may be more water efficient than washing up by hand (*Market Transformation Program (5), 2008*). In practice, however, the water and energy impacts of washing up are heavily dependent on the individual users' behaviour. Typical per cycle water usage for dishwashers is shown in Table 41.

Table 41: Typical per cycle water usage for dishwashers

Component	Typical consumption (litres per load)	Range of consumption (litres per load)
Manufactured before 2000	25	15-50
Manufactured post-2000		
Normal setting	14	7-19
Eco-setting	10	8-12

A database of dishwasher models available on the British market in 2007, which is representative of about 30 brands shows that capacities vary from 6 to 15 PS, with the most commonly occurring capacity being 12 PS. Overall, mean water consumption was 14.10 l/cycle, with a mean water efficiency index of 1.22 l/cycle/PS. Mean water consumption for 12 PS machines was 14.62 l/cycle, with a mean water efficiency index of 1.22 l/cycle/PS. Figure 30 (below) illustrates the distributions of water consumption and water efficiency in the United Kingdom in 2007.

Figure 30: Distributions of water consumption and efficiency of dishwasher models available on the United Kingdom market



Information on dishwasher usage in households collated from European studies is presented in Table 42 below.

Table 42 : Summary of water consumption and frequency of use of dishwashers

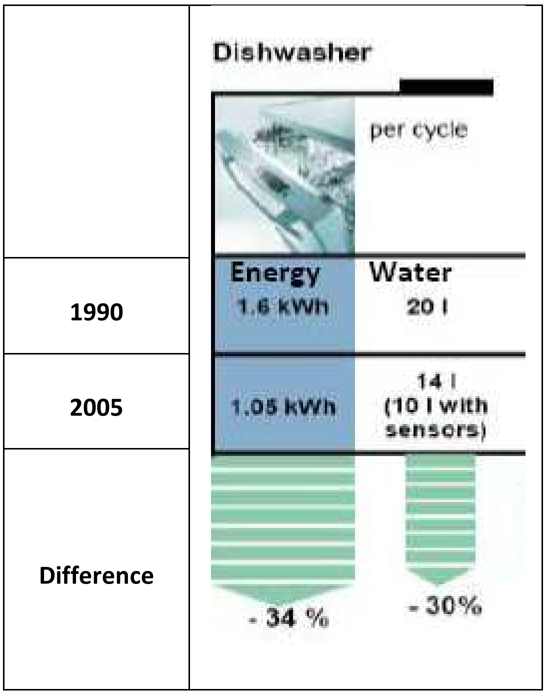
Country	Average water consumption (l/cycle)	Frequency of use (use/household/ day)	Average total water consumption (l/day)	Data source
England	21.3	0.71	15.12	*WRc, 2005*
Portugal	29.0	0.5	14.50	*Viera et al., 2007*
France	24	-	-	*Etelmaki, 1999*
Germany	27-47	-	-	*Etelmaki, 1999*
England and Wales	35	-	-	*OFWAT, 1997*
Finland	25	-	-	*OFWAT, 1997*
Range (Europe)	**21.3-47**	**0.5-0.71**	**15.12-33.37**	**as above**

- **Dishwashers and energy use**

As with washing machines, water use in dishwashers correlates to energy use.

Figure 31 shows trends in energy and water consumption of Bosch und Siemens Hausgeräte appliances from 1990 to 2005.

Figure 31: Water consumption of Bosch und Siemens Hausgeräte dishwashers from 1990 to 2005



3.1.4.7 Garden irrigation (water hose + sprinklers)

➢ **Standard product**

Flow rates for standard technology for reticulated and manual garden irrigation are summarised in Table 43.

Table 43 : Flow rates for standard technology for reticulated and manual garden irrigation (*Waterwise (1), 2008*)

Component	Typical consumption (litres per hour)	Range of consumption (litres per hour)
Hosepipe with trigger gun/nozzle	600	400-800
Hosepipe without	1 000	600-1 200
Sprinkler	1 000	600-1 200

➢ **Water-efficient alternatives**

For houses with gardens, water saving devices can be offered together with literature advising customers of how to be water efficient in the garden. Examples of good devices to offer customers include water butts and trigger hose guns (if no hosepipe ban exists in the customers' area).

The impact of 10 water conservation programmes in the United Kingdom involving options to reduce outdoor use are presented in Table 44.

Table 44 : Results from household irrigation programmes in the United Kingdom between 1997 and 2008

Company	Project	Year	water butts	Hose gun	Soil crystals
ESW	Moulsham	1997	2.47	-	-
ESW	Chelmsford-full	2005	1.58	1.20	-
ESW	Brentford	2004	-	1.58	-
ESW	Romford	2004	-	1.58	-
SWW	Multi-measure	2005/06	-	0.28	-
ESW	Witham	2002	-	0.74	-
ESW	Thurrock	2006/07	-	1.51	-
ESW	H2eco	2007/08	1.79	1.35	0.02
SES	Preston-retrofit	2007/08	4.76	-	-
YOR	Water Saving Trial	2007/08	-	0.76	-
Number of projects included in assessment			4	8	1
Savings range for assessment (l/prop/day)			1.58-4.76	0.28-1.58	0.,02

ANG = Anglian Water; SES = Sutton & East Surrey Water; TW = Thames Water; ESW = Essex & Suffolk Water; STW = Severn Trent Water; UU = United Utilities; EA = Environment Agency; SWW = South West Water; YOR = Yorkshire Water

3.1.4.8 Cooling systems used in residential buildings

In general, there is an absence of data on how much water is typically used by cooling systems in households. However, some general observations can be made. The water use for air-conditioning units shown in Table **45** below is based on a 3.5 kW per unit capacity.

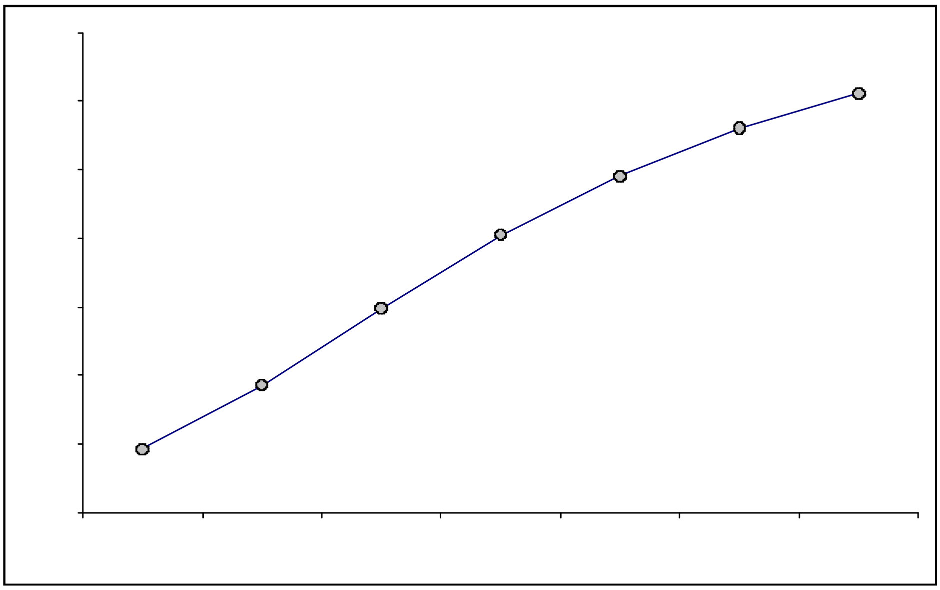
Table 45: Lifetime water use for 3.5 kW air-conditioning unit (reversible and cooling only) (*Armines, 2007*)

Type	Lifetime water use for cooling (litres)	Expected lifetime
Moveable Room Air-Conditioners (RAC)	165 098	12
Split cooling only	170 230	12
Reversible split	353 016	12

Available information states the environmental impact of larger units does not differ much from 3.5 kW units, except that, being less efficient, the importance of the use phase is still emphasised. No data were available to verify whether this means that water use is the same for higher powered units.

The graph in Figure 32 is from an assessment of the total water use of Room Air Conditioner between 2005 and 2030 over EU-25 (*Armines, 2007)*. This is essentially the business as usual case and assumes no changes in the product, or the way in which it is used (e.g., cooling demand which needs to be met).

Figure 32: Assessment of the total water use of Room Air Conditioner between 2005 and 2030 over EU-25



3.1.4.9 Commercial urinals

- **Standard product**

A recent Water Efficiency Solutions report (*ECA, 2008*) estimates that the flushing of urinals accounts for between 20% and 30% of a commercial organisation's water consumption. The report also cited the calculation that a single urinal with a half-hour flush pattern consumes nearly 125 000 litres of water per year.

Urinal flushing mechanisms can be cyclic 'fill and dump' units, which as mentioned above are highly inefficient, manually operated cistern (concealed push button or exposed overhead chain-pull), lever operated flush-o-meter, or a movement sensor controlled solenoid valve.

Water volumes per use for urinals are commonly as high as 3-4 litres per flush. Urinals can be either a multi-user trough or individual wall hung pods. Consumption depends on usage levels, equipment type and settings, and can vary from 50 m^3 to 100 m^3 per year (30-70 flushes of 4 litres each per day).

- **Water-efficient alternatives**

As shown in Table 46, from an example of using different types of urinals in commercial buildings in Sofia, Bulgaria (Dimitrov, 1998), a key design criterion that affects water consumption for urinals is the mechanism that controls the flush frequency.

Table 46: Potential water savings from replacement of urinals in commercial buildings

Building type	Occupant	Urinals (no. of flushes per month)			Urinals (volume used per month)			Potential saving %		
		Self-flushing	Cycle	Sensor	Self-flushing	Cycle	Sensor	Self-flushing	Cycle	Sensor
Offices	12	5 400	148.5	6 534	162	44.55	19.6	Standard	72.5%	87.9%
Restaurant	250	8 640	3,000	15 000	259.2	90	45	Standard	65.3%	82.6%
School	100	4 320	650	3 750	129.6	19.5	11.25	Standard	85.0%	91.3%
Public WC	1,200	14 400	9 360	36 000	432	280.8	108	Standard	35.0%	75.0%

A number of case studies where urinals have been replaced in commercial buildings in Europe, Australia and the USA are presented in Box 2 below.

3.1.4.10 Commercial taps

- **Standard products**

Conventional taps, with typical flow rates of 9.5 to 15 l/min, can waste as much as 150 litres of water a day when not fully closed (*North Carolina Department for Environment and Natural Resources, 2007*).

About one third of the water used in every office comes through the tap. Installing taps with high quality flow regulated sprays can reduce this amount by up to 80 per cent. When installing new taps, specifying models with metric outlets, allows the flexibility to add a range of outlet devices such as sprays and aerators *(UK Environment Agency, 2007).*

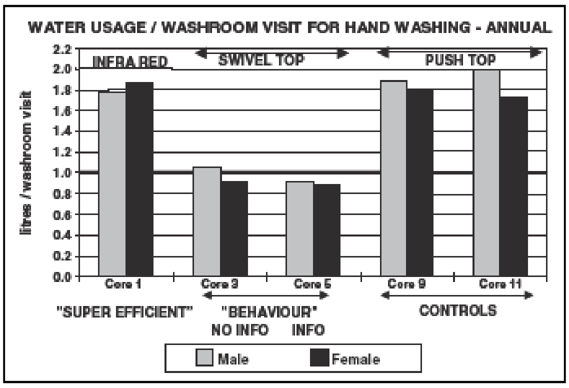
- **Water-efficient alternatives**

If infra-red technology is installed, care needs to be taken when installing and setting-up the equipment. In one of the largest studies of its kind – the Millennium Dome WaterCycle experiment (*Hills, 2001*) – three types of tap were evaluated, infra-red activated (48 in total), push-top (96 in total) and conventional swivel top (96 in total). Surprisingly, over the year the conventional swivel top taps used significantly less water than the purported more efficient types (see Figure 33) with each user of the swivel top taps using, on average, just less than 1 litre of water.

For manually operated swivel top taps, the optimal value for a single hand wash would appear to be approximately 0.9 litres per use (see Figure 33).

During the course of the Millennium Dome study, problems with the functioning of the infra-red and push top taps were identified from the metering data. These were again traced to problems of poor installation and set-up. A retrofit of the push top taps, so they flowed for 7 seconds rather than 15 seconds after activation, resulted in a significant reduction in water usage.

Figure 33: Mean volume of potable water used for hand-washing (litres per washroom visit) by males and females



Positive results for infra-red sensitive taps have, however, also been recorded. In the Hafod Country House Hotel, near Llanrwst in the Conway Valley, North Wales, where more than a third of the water use for the building is used within the kitchen, leaking kitchen taps that were also commonly left running were replaced with infra-red controlled taps and were found to be very effective. In combination with other efficiency measures, the total water use of the hotel was reduced by 15 per cent per guest, per day, resulting in a saving of £139 per year.

Box 2: Impacts of Urinals replacement programmes

Europe

- The Arenson group, which is involved in office furniture manufacturing, implemented a number of simple water saving measures in the non-manufacturing processes (installing passive infrared detectors in urinals, for example, to prevent unnecessary flushes, on-going maintenance to maintain spring-loaded taps, check water meters to ensure no water is wasted from leaks, etc). As a result, water use in factory/office washroom environments was reduced by 45% from 3,800 m^3/year to 2,100 m^3/year, equivalent to cost savings of £3,000/year.
- The Wilton Park Conference Centre employs 51 to 60 persons. It has installed new urinals set to save 511 cubic metres of water each year. The urinals cost £1,000 to install, and have a payback period of approximately two and a half years.
- The Environment Agency offices in North West England were found to be using more than 300 litres of water per hour when the office was unoccupied. By changing urinal controls were changed, this reduced to 10 litres per night.
- The Gwesty'r Llew Coch Hotel at Dinas Mawddwy in North Wales is a rural hotel with only six rooms, and not connected to sewerage mains. Despite this, the hotel used more than 15 000 litres of water per guest, per day. On investigation, more than one third of this was found to be from a single uncontrolled urinal. Replacing this urinal immediately saved more than £100 per year.

Australia

- The city of Borondara decided to replace full flush toilets with dual flush toilets and 7 water flushing urinals with waterless urinals at four public facilities. Potential savings have been assessed at 789 m^3 per year with a cost of $38 315.
- The Newmarket State School expects to save more than 150,000 litres per year by installing 18 dual flush toilets, 2 waterless urinals, using rainwater collected in tanks to supplement toilet water supply and installing irrigation controllers for the garden with rainfall and soil moisture sensors. The cost of the total project is estimated at $45 454.

3.1.4.11 Commercial toilets

- **Standard products**

WCs or toilets can use anywhere from 11 l/flush for the older models down to 4 litres for the latest designs. WCs in commercial buildings are generally used more frequently than those in residential buildings, meaning higher potential lifetime water savings, and they also have different design requirements, e.g. faster cistern refilling times.

For commercial and public buildings, a relatively high utilisation rate of 50 flushes per day can provide total water savings of about 170 l/day (more than 60 m^3 per year) by the replacing of an 11 litre single flush by a 4 litre single flush or 4.5/3 litre dual flush unit. Water savings and costs of implementation will vary greatly depending on the level of use, specific water savings measures, type of pan installed, and factors such as the plumbing arrangements, and the architectural finishes. It is usually considered uneconomic to replace older style WCs except as part of a major building or floor upgrade.

- **Water-efficient alternatives**

It is not always feasible to replace less efficient WC units completely, but there are retro-fit options available. For example, some toilet bowls with 11 litre cisterns can accept a simple replacement cistern, e.g. 6/3 litre dual-flush cistern, and this is can be very cost effective (payback period of 2-3 years or less). However, some bowls will not clean solid waste properly with the reduced 6 litre flushing volume and for this reason, British buildings regulations[39] state that "if any existing flushing cistern needs to be replaced without changing the WC pan, the new cistern should be of the same flush volume as the one being replaced, which may be a single or dual flush. A single flush cistern may not be replaced with a dual flush cistern. Where dual-flush cisterns are renewed the lesser flush volume is not to be greater than 2/3 of the total flush volume".

3.1.4.12 Commercial ice makers

Ice makers use more water than just the water contained in the ice. This equipment can often be very inefficient in water use depending on the type of machine and the desired type of ice. Ice machines are composed of the following components: a condensing unit used for cooling, an evaporator surface for ice formation, an ice harvester, an ice storage container, and, in some models, a dispenser. The type of condenser an ice machine uses will have the largest effect on water use. Two types of condensers are available: air-cooled and water-cooled.

The air-cooled units are usually more water efficient; while the water cooled units are usually more energy efficient, however, not all literature sources agree on this. Both types vary greatly in water efficiency, even for a given design type. Ice-makers are

[39] Water Supply (Water fittings) Regulations 1999: WC Suite Performance Specifications.

often located above an insulated storage box and are specified by their nominal capacity, defined as the weight of ice produced per 24 hours. Typically the capacity of ice-makers ranges between 110 kg/24 hrs and 650 kg/24 hrs. They are typically referred to as “automatic ice-makers”.

The typical icemaker can use up to 2 or 3 times more water than needed to make the ice. A number of factors influence water consumption, such as technologies used to produce different types of ice, the degree of water recycling; and the frequency of ‘flushing through’ with fresh water (*Mark Ellis and Associate, 2004*). Generally, water consumption is measured in terms of the volume required per mass of ice produced - ‘litres of water per kg of ice produced’. Most ice makers’ water use ranges between 1.5 to 16.7 litres of water per kg of ice.

3.1.4.13 Commercial washing machines/laundries

Depending on the machine type, volume of water consumed per cycle varies greatly. The initial wash cycle uses the most water because it must saturate the material and fill the wash wheel. These larger volumes also help to carry away the larger proportions of contaminates encountered in the initial wash phases. Rinse cycles use the least amount of water, sometimes as little as 35-60% of the amount used in the initial wash. Water is extracted between each step of the wash cycle before clean water is injected into the wash wheel (*Sullivan et al., 2008*).

3.1.4.14 Commercial dishwashers

The gallons/rack rating is a function of water use (in gallons per hour) and wash, rinse, dwell, and load time.

Water usage across commercial dishwasher classes does not appear to be directly related to the size of the machine and varies from 1.25 litres per dish rack (or per full load of dishes). A typical commercial dishwasher consumes approximately 15 litres per dish rack (*Alliance for Water Efficiency, 2008*).

3.1.4.15 Commercial garden irrigation (golf terrains and sprinklers)

See section 3.1.4.7, page 108.

3.1.4.16 Commercial car washes

- **Standard product**

Table 47presents typical water use for automatic carwashes.

Table 47 : Typical consumption for carwashes (*Brown, 2002*)

Component	Typical consumption (litres per event)	Range of consumption (litres per event)
Drive-in, conventional	150	80-300
Drive-in, reuse water	30	10-50
Drive-in, pressurised spray	50	45-55
DIY, hosepipe with trigger gun/nozzle	300	150-400

Component	Typical consumption (litres per event)	Range of consumption (litres per event)
DIY, bucket	35	10-70

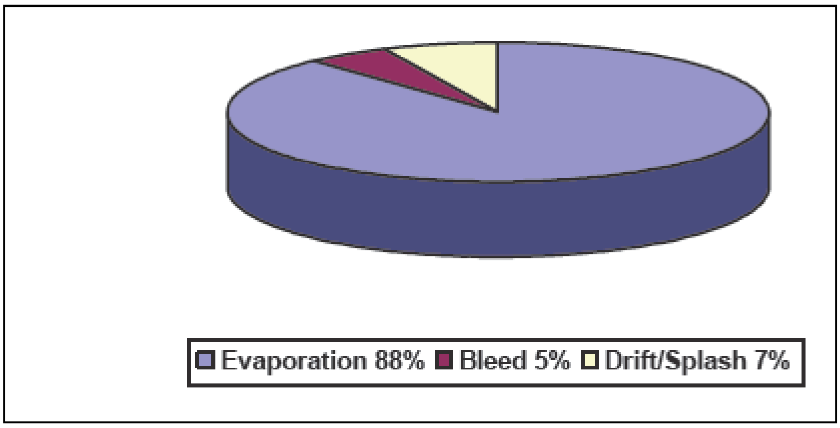
- **Water-efficient alternatives**

A US study claims that, on a gallon-per-vehicle (gpv) basis, professional car washes use a minimal amount of water when conservation equipment, including reclaim systems, is installed. When no reclaim system is installed, water use can range from a low of 15 gpv for self-service car washes to a high of 85.3 gpv in a frictionless conveyor car wash for basic wash using equipment and optimal operating parameters for water efficiency. For professional car washes using separation reclamation, the range varies from 30 gpv for in-bay automatics to 70 gpv for frictionless conveyor car washes. When a reclaim system with full filtration is used, the range is estimated from 8 gpv for in-bay automatics to 31.8 gpv for frictionless conveyor car washes.

3.1.4.17 Cooling systems used in commercial buildings

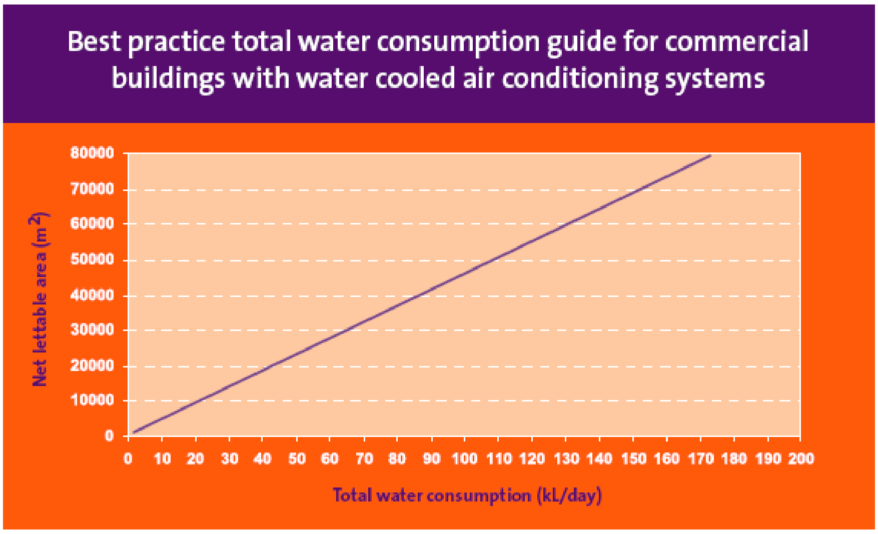
The pie-chart shown in Figure 34 is based on Australian data, and shows a typical breakdown of evaporation, bleed/blow-down, drift and splash (these terms are explained below) in a well-designed tower. In Australia, AC units can account for 30-40% of total water consumption in buildings with cooling towers. This percentage can be higher if the system has leakage, water treatment or overfilling problems. These losses are compensated by make-up water (usually from the potable water supply) which is added to the basin and regulated via a float valve. The percentages shown are of the circulating cooling water. For a 1050 kilowatt tower this could be 25 l/minute. The bleed shown is for cycles of concentration ratio of 2. Improving this ratio from 2 to 12 can save 45% of water use (10-11 l/min).

Figure 34: Water consumption for a well-maintained cooling tower



A benchmarking study *(Sydney Water, 2008)* has developed a water consumption guide for commercial buildings with water-cooled air conditioning systems, which includes the graph shown in Figure 35.

Figure 35: Best practice guideline for cooling towers: Sydney water



3.1.4.18 Overview of water efficiency of different WuPs in buildings

Consumption data for different WuPs were collected for this study, and are summarised in Table 48 below.

This summary data indicates that average daily household water consumption in Europe is approximately 326 litres. Assuming an average occupancy rate of 2.5 persons per household, this equates to a daily per capita consumption of 137.7 litres. It should be noted that these figures have been calculated based on some assumptions in order to determine potential water savings, and should not be taken as an accurate indication of the actual consumption in Europe. This figure appears to follow the 150 l/capita determined in the literature (*Dvorak et al, 2007*).

Some discrepancies can be expected as the methods of calculation, product types, and base figures considered may differ across MS. However, despite these differences, the pattern of household consumption seems to be in agreement with figures determined in other studies. In a study running in parallel to this one (*BIO, 2009*), it was determined that household consumption takes up a 60 to 70% share of EU **public water supply**[40]. For a total of 197 million households in Europe[41], and a calculated yearly consumption of approximately 125 698 litres per household, the total yearly household consumption is estimated to be 25 trillion litres. This represents approximately 60% of the EU public water supply. Furthermore, considering the results of a previous study on water saving potential in Europe (*Dworak et al. 2007*), which considers a yearly household consumption of 136 969 litres (150 l/capita/day, for a 2.5 person household), this is equivalent to 66% of the yearly public water supply.

[40] Note here that public water supply refers only to the water destined for use by residential and commercial buildings, as well as small industries which do not have access to a private water supply (i.e. not possessing a water extraction permit).

[41] Number of households in EU ≈ EU population/average number of person per household

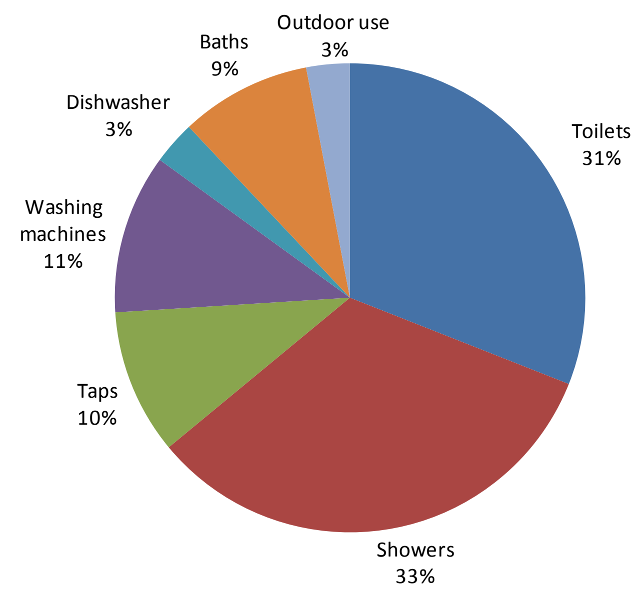
Figure 36 shows the average percentage of total household consumption, broken down for different WuPs present in residential buildings, based on data presented in Table 48.

Table 48: Summary of residential WuPs consumption data for EU MS

WuPs	Average water consumption per use	Frequency of use per person, per day [a]	Average water consumption (l/household/day)	Share of household consumption (l/household/day)
Toilets	9.5	4.2	100	31%
Showers	50	0.85	107	33%
Taps	1.1	1	31	10%
Washing machines	60	0.6	37	11%
Dishwasher	20	0.57	11	3%
Baths	80	0.14	29	9%
Outdoor use	4.3	1	11	3%
Total	-	-	**326**	-

[a]Assuming a 2.5 persons/household
[b] Maximum for European range (Table 31)
[c]Based on a five minute power shower using 10 l/min of water (*Sim et al., 2007*) with 6 showers per person, per week.
[d]Assuming 12 uses per person per day (*Sim et al.,* 2007), 6.5l/min and an average 10 sec use.
[e]Asssuming 4.3 washes per household per week.
[f]Assuming 4 washes of 20 litres per week (*Stamminger et al., 2004*).
[g] Assuming one bath taken per person, per week.
[h] Assuming an annual averaged value of 4.3 litres per head per day (*Herrington, 1996*).

Figure 36: Average household water use percentage per product type



If we disaggregate this overall water reduction potential by individual WuPs, it is evident that the highest savings can be achieved through promoting high-efficiency toilets (53%) (Table 49). All products could potentially achieve reductions in water consumption around the 20% mark. It should be noted that, with the exclusion of toilets, the majority of the figures have been based on the water consumption of newest available standard products. The figures for consumption savings could be considered somewhat conservative for the most cases, and actual savings may be much higher. By installing water efficient devices, the literature estimates a water savings potential between 29 and 41% per household (with the exclusion of outdoor WuPs) (*Dvorak et al., 2007*). Using the data presented in Table 49 our results correspond to those in the literature, showing potential water saving in **household** consumption of approximately 32%.

Table 49: Potential household water savings from water efficient appliances

	Standard product		**Water efficient product**		**Standard vs. efficient**
WuP	*Litre/use*[a]	*Litre/household/ day*	*Litre/use*	*Litre/household/ day*	*% reduction*
Toilets	9.5	100	5 [b]	53	53
Shower	50	107	40 [c]	86	20
Taps	1.1	31	0.8 [d]	24	23
Washing machine	60	37	41 [e]	25	32
Dishwasher	20	11	9 [f]	5	55
Baths	80	29	65 [g]	23	19
Outdoor	4.3	11	3.3 [h]	8	23
Total	**-**	**326**	**-**	**224**	**32**

[a] Assumed use patterns are from in Table 48, unless otherwise stated.

[b] Based on a 6/4.5 dual flush toilet (assuming 1:2 use ratio, at an approximate average of 5l/flush).

[c] At a water consumption of 8 l/min.

[d] Assuming water consumption of 5l/min.

[e] Based on average ecodesign requirements.

[f] Based on average ecodesign requirements.

[g] Reduction figure based on Ecologic report (*Dvorak et al., 2007*)

[h] Estimated 3.3 litres per head per day when replacing sprinklers and hosepipes with hose guns.

Table 50 provides a summary of water consumption and frequency of use per unit for WuPs used in commercial buildings. Most of the data in the literature is provided as either water usage per person (e.g. employee, guest, patient), usage per floor-space (i.e. m^2) or as an end-use percentage (kitchen, laundry, swimming pool etc.). This review suggests that there is a requirement for more detailed micro-component studies for different types of buildings (i.e. offices, schools, hospitals, hotels etc). From the collected information, however, it can be concluded that the high frequency of usage in commercial buildings makes it a priority to take further action on improving water efficiency of urinals, taps, and WCs at large commercial offices, schools, hospitals and hotels.

Table 50:
Summary of WuP water consumption in commercial buildings

WuP	Average water consumption per use	Frequency of use per day	Average water consumption per day (l/unit/day)	Range water consumption per day (l/unit/day)
Urinals	1-4 l/flush	30-70*	150*	30-280*
Taps	2-20 l/min	5-50	-	-
WCs	4.0 - 9.5 l/flush	5-50**	247.5**	20-475**
Dishwasher	1.25 l/dish rack	-	-	-
Washing machines	-	-	-	-
Commercial car washer	50-150 l/use	-	-	-
Cooling towers	0.2 l/m^2 floor-space	-	171	114-228

*The range of reported savings from replacing urinals indicate that, in some cases, flush frequencies and consumption of older self-flushing urinals in commercial buildings can be much higher than the volumes quoted here.
**This evidence is anecdotal

3.2. WATER USE IN INDUSTRY

3.2.1. OUTLOOK OF WATER USE IN INDUSTRY

Most industries are dependent on the adequate supply of water for steps such as production, processing, cleaning, cooling, and/or heating. Indeed, energy production has been identified as the most significant water consuming sector in Europe (see Figure 1, pg. 17 and Figure 37, pg. 113). Furthermore, industry represents between 11% and 15% of total water abstraction in EU. In the past, water quality in industries, both for supply and discharge, has received a great deal of focus. As water scarcity becomes an increasingly important issue in Europe, industries will also be compelled to optimise their water consumption.

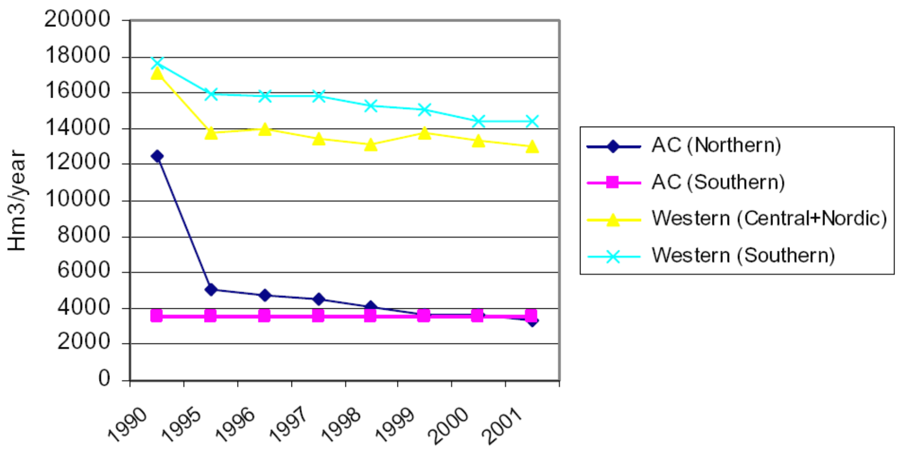
3.2.1.1 Industrial water use in Europe

The total water use for industry in Europe is 34 194 Hm^3 /year which accounts for 18% of its consumptive uses. In 2001, industrial water use represented 37% of the consumptive uses in Western Europe (central and Nordic), and 13% of the consumptive uses in southern Europe.

The amount of water used by industry has decreased in all the European regions during the period 1990-2001, as illustrated in Figure 37, as a result of measures to reduce demand and due to economic restructuring. Indeed, different changes occurred during this period, which influenced the industrial water use: decline of industrial production, use of more efficient technologies with lower water requirements, and the use of economic instruments (charges on abstractions and effluents).

The intensity of water use [m^3/(€1 000 gross value added)] varies tremendously from one industry to another, e.g. in Finland it is about 138 m^3/(€1,000 gross value added) in the paper industry and only 1 m^3/(€1 000gross value added) in the textile industry. Therefore, some industries, including the production of paper, food, chemicals and mineral products, are clearly much more water-intensive than others (*Flörke et al., 2004*).

Figure 37: Trends in water use for industry (*Lallana et al., 2004*)



3.2.1.2 Industrial water use in different MS

As seen above, industry consumes a significant amount of water in the overall European water consumption profile. However, this varies from one MS to another, and so too do the industrial activities within a MS. Despite these variations, it is still possible to identify the industries which consume the most significant amount of water in different MS. During the literature review, the share of water use for different industries was estimated for five MS – United Kingdom (*Office for National Statistics, 2001*), Spain (*Prointec, 2008*), France (*Bouvet et al., 2007*), Portugal (*Silva et al., 2002*) and the Netherlands (*Netherlands Environmental Assessment Agency, 2005*). The highest water consuming industries were ranked from 1 to 5 (1 = least consuming, 5= most consuming) according to their share of water consumption within each MS. Table 51 shows the results of this ranking by share of water consumption.

Table 51: Ranking of industries according to national industrial water use

MS	*Chemicals*	*Thermo-electric Energy*	*Food and beverage*	*Fuel Installations*	*Metals production & transformation*	*Pulp, paper and cardboard*	*Waste and residue management*	*Textiles*
UK	4	5	2		3	1		
ES	3		4	1	5		2	
FR	5		1	4	3	2		
PT	2		4		3	5		1
NL	2		5	3		4		
Total	**16**	**6**	**16**	**8**	**14**	**12**	**2**	**1**

Despite some variations, the table above seems to indicate a pattern in consumption by different industries across MS. Considering that various different types of industries exist within Europe, the above matrix shows that certain industries regularly show up as more water consuming. Variations can be expected as the economic and industrial profile differs for each MS. It is important to note that some of the above sources do not take into account water consumption by the energy production industry. A recent study shows that, on average, 44% of total water abstraction in EU is used for energy production (*Dworak, et al. 2007*), while another previous one suggests that 18% is used for energy production in Europe (*UNEP, 2005 a*). Following is a list of industries judged as having high water consumption:

- Energy production
- Food and beverages
- Metal production and transformation
- Chemicals
- Paper and card

3.2.2. SCOPE DEFINITION

A large number of industrial sectors depend on an adequate supply of water for various purposes. Due to varied processes in different industries, an array of different WuPs are employed for production and processing and they are specific to each process. This study focused on industries that consume the greatest quantity of water and the WuPs used there are analysed in more detail.

In section 3.2.1. most water intensive industries in Europe were identified. Below, a brief description is provided for the WuPs considered consuming the greatest amount of water in each of these industries:

- **Energy production:** Although the fuels (and thus processes they are based on) used in the energy production industries may differ, the majority of these industries rely on two significant WuPs – **boilers and cooling towers**. The specific aspects of water consumption by these two products are essentially dealt with in specific sub-sections (see 3.2.3. on steam generation and cooling and heating equipment, pg. 116-120).

- **Metals production and transformation:** These industries tackle a vast array of metals, all of which need a large amount of water during manufacturing. Metals also undergo finishing and transformation steps which involve a variety of machines many of which also require water. It would be very difficult to tackle WuPs used in metal production individually as they are often tailor made according to the clients' specifications, and there are significant differences between equipment used for different types of metals. Nevertheless, the most significant amounts of water used in the metals production and transformation industries are for cooling or heating. Cooling towers and boilers are two of the main WuPs for these purposes and will be dealt with in their respective sub-sections in section 3.2.3.

- **Chemicals production:** Chemical industries consume significant amount of water. However, the processes involved in this type of industry, and consequently the water consuming products used, vary greatly. A vast amount of water is also used to dilute chemicals, which cannot be considered water consumption by a water using product. Data on water consumption in this sector is quite scarce and therefore it is difficult to identify the most significant water using products. Schemes such as water reuse and recycling may prove effective in reducing the water consumption within this industry.

- **Food and beverage production:** As with the chemical industry, the food and beverage production and processing industry encompasses an array of WuPs, some of which are specific to certain types of food. Due to the diversity of products it would be difficult to consider all water consuming products within this industry. However, there are products which are common across these types of industry and have a potential for improvement. As different products contribute to the high water consumption in this industry, it may be more effective to optimise the water consumption at the plant level, rather than individual products. Plants are often reluctant to replace old and inefficient technologies due to pay-back time being uncompetitive (*Champions' Group on Water, 2007*). There is also concern that new technologies may not comply with hygiene and safety standards required within this sector. Setting targets across industries or metering water consumption could encourage food and beverage industries to not only adopt best practice methods (which include replacing inefficient products) as well as considering recycling and reuse schemes. In the past, reuse schemes were deemed unsound for use in this industry due to strict hygiene standards. However, European legislation seems to be changing which may allow for the introduction of closed looped systems as long as '*the competent authority is satisfied that the quality of the water cannot affect the wholesomeness of the food stuff in its finished form* (*Dworak et al., 2007; Regulation (EC) 853/2004*)

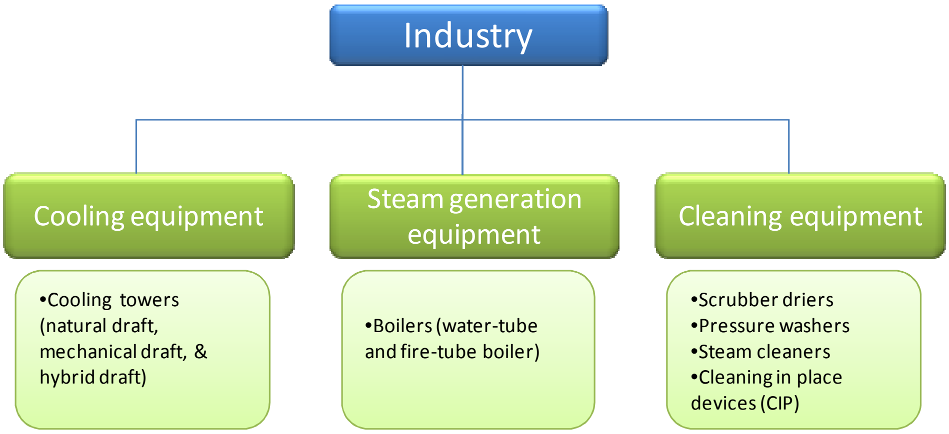
- **Paper production:** The paper production industry is often one of the most water intensive industries. Different steps, from pulp production to final product production (e.g. paper, cardboard, etc.), require large amounts of water. Although many products may be commonly used across these industries, the actual volume of water used per tonne of paper produced depends on several factors including type of end-products, equipment used, arrangements of the equipment, production processes, and the operation conditions and parameters (*Barr, 2008*). As with the food and beverage industry, reducing water use in this sector may be more effectively achieved by introducing plant-wide schemes and regulations which would provide an incentive for companies to adopt best practice measures. Boilers and cooling towers also make up an important part of this sector, and affect the total water consumption. These will be dealt with in later section 3.2.4. , pg. 128.

As demonstrated above, the diversity of the processes involved makes it difficult to consider all industrial WuPs used in these sectors. This study mainly focuses on common processes and equipment used in different industries. Consequently, the following equipments are considered within the scope of this study:

- Equipment used for cooling
- Equipment used for steam generation
- Equipment used for cleaning

The following figure illustrates the main WuPs in industry that will be further analysed in the following sub-section, which will look at the specific WuPs in more detail.

Figure 38: WuPs used in industrial setting



3.2.3. Categories definition

3.2.3.1 Cooling equipment

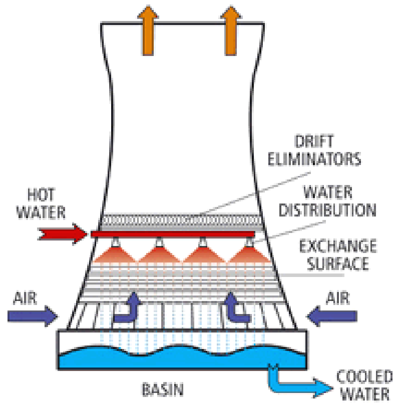
Definition: Cooling equipment encompasses both refrigeration and air conditioning. The products dealt with in this section will refer specifically to those used for cooling in industrial production and processing. This excludes products used for commercial refrigeration and air conditioning of buildings. The most evident water consuming product for this purpose is cooling towers.

Cooling towers are used in a variety of applications. They are most commonly used for heat removal during industrial processes (in comparison to once through cooling and cooling ponds). Unfortunately, despite their cooling efficiency, they consume vast amounts of water even when properly maintained.

➢ **Natural draft cooling towers**

Definition: Natural draft cooling towers utilise no mechanical fan to create air flow through the tower. Warm, moist air *naturally* rises due to the density differential to the dry, cooler outside air. Warm moist air is less dense than drier air at the same pressure. When they come into contact with one another, a current of air is produced through the tower which cools down the water flowing through.

Figure 39: Natural draft cooling tower



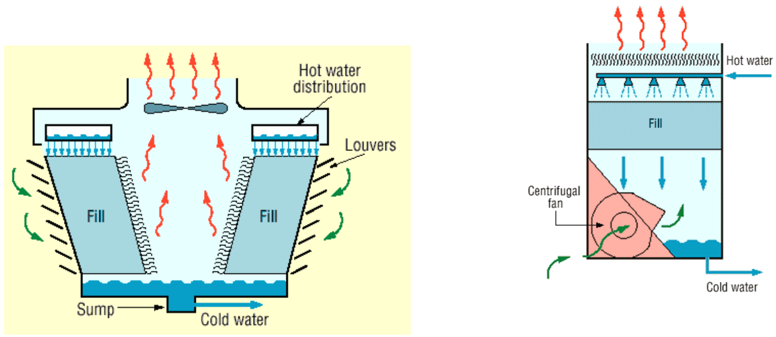
➢ **Mechanical Draft**

Definition: Mechanical draft towers use fans (one or more) to move large quantities of air through the tower. They are two different classes of mechanical draft towers (see Figure 40):

(a)*Induced draft*: A mechanical draft tower with a fan at the discharge which pulls air through tower. The fan *induces* hot moist air out of the discharge.

b)*Forced draft*: A mechanical draft tower with a blower type fan at the intake. The fan *forces* air into the tower, creating high entering and low exiting air velocities.

Figure 40: Types of mechanical draft cooling towers



(a) (b)

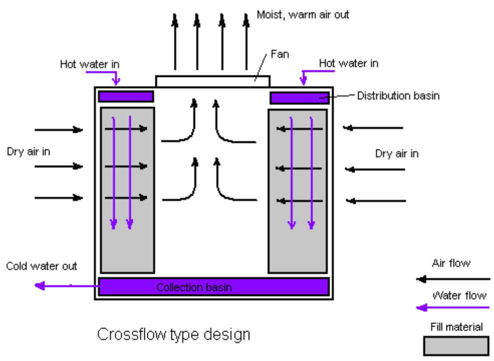
➢ **Hybrid Draft**

Definition: These are natural draft towers which are equipped with mechanical draft fans to augment airflow. They are also referred to as fan-assisted natural draft towers.

Furthermore, mechanical draft cooling towers can be further subdivided into two categories seen in Figure 41 and Figure 42 depending on the direction of the air and water flow within the tower:

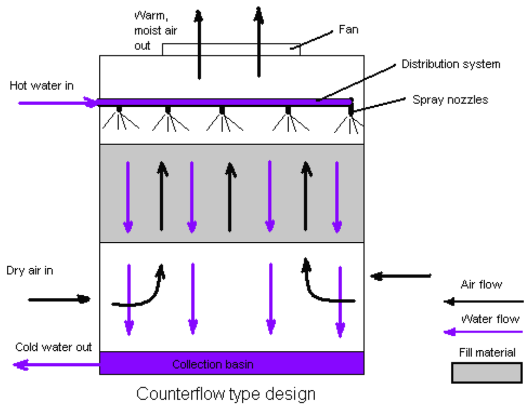
- **Cross-flow:** A design in which the air flow is directed perpendicular to the water flow.

Figure 41: Cross-flow cooling tower



Counter-flow: In a counter-flow design the air flow is directly opposite to the water flow.

Figure 42: Counter-flow cooling tower



Potential for improvement

Excessive blow-down can lead to inefficient use of water. Some steps can be taken to ensure that blow-down occurs at the correct stages. Alternative technologies are available to reduce both water lost through evaporation in the cooling tower, and water removed through blow-down. Some examples of things that can be done to reduce water consumption include (*Campus Environmental Resources Centre, 2007*):

- Using a total dissolved solids (TDS) meter/controller to maintain proper bleed-off rates.
- Increasing the frequency of cleaning the cooling system
- Using acid treatment controllers and filtering equipment
- Conducting frequent chemical analyses to define TDS levels and, therefore, when cleaning should take place.
- Consider using such techniques as ultrasonic imaging, thermocouples, removable test strips and fiberscopic inspections to determine the location and/or type of deposits.
- Consider sampling tubes and pipes annually to track scale build-up.
- Consider controlling the composition of the feed water through an elevated oxygen treatment process, which has been found to result in less frequent cleaning.

Another method of reducing water consumption includes using water recirculation technology in the cooling tower. However, this often results in a large reduction in plant efficiency (approximately 3-5%) (*World Nuclear Association, 2008*). Despite this disadvantage, cooling towers with recirculation systems are quite commonly used, especially in the energy generation industry.

Market trends

Cooling towers are classified under the PRODCOM category 29.24.40 "*Machinery n.e.c. for the treatment of materials by a process involving a change of temperature*"**.** Table 52 shows the total production of cooling towers extracted from the PRODCOM database. It appears that production in Europe has declined by approximately 29% between 2004 and 2007. Although this could be an indication of falling demand, import and export data need to be investigated to determine the true number of units sold in Europe.

Table 52: Cooling tower units produced in EU-27 between 2004 and 2007

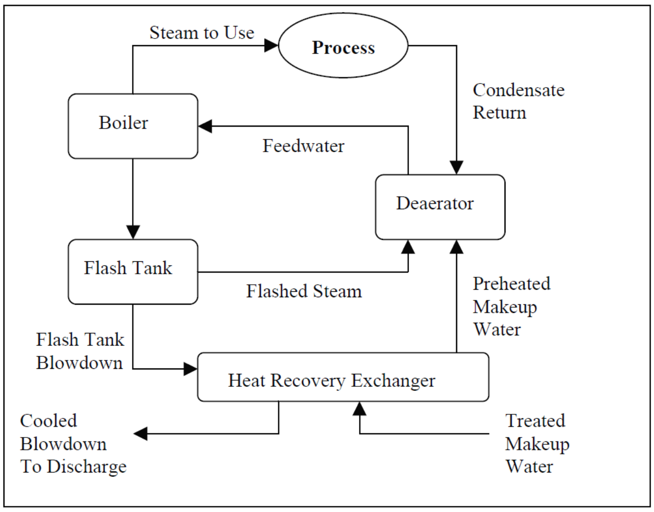
Cooling Equipment	2004	2005	2006	2007
Cooling towers and similar plant for direct cooling by means of re-circulated water[43]	56 582	53 741	35 000	40 000

3.2.3.2 Steam generation equipment

Definition: Steam generation, both for processes and electricity production, is carried out by boilers. As with cooling towers, boilers and flash tanks lose water mainly through evaporation and removal (blow-down). There are many types of boilers and flash tanks used in industrial settings. Steam lost may be considered leakage and may be excluded from the scope of the study. Therefore, losses through blow-down would be analysed for the purposes of the scope.

Boilers for steam generation can be divided according to different configurations. It is unclear at present whether the configuration of the boiler can influence the consumption of water. However, to simplify the scope, product design has been used to classify products hereafter.

Figure 43: Schematics of a heat exchange system which includes a boiler

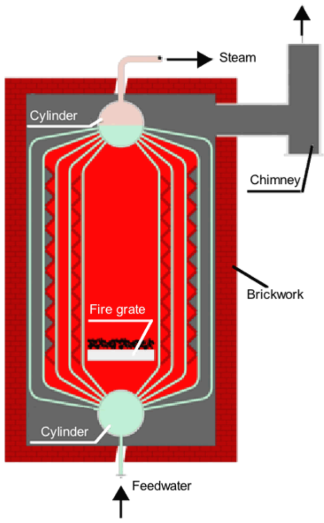


[43] PRODCOM code: 29.24.40.30 Cooling towers and similar plant for direct cooling by means of recirculated water

Water-tube boiler

Definition: Water-tube boilers contain a series of tubes filled with water which are arranged inside a furnace and heated externally. Water is fed into a feed-water drum (or cylinder), heated by the furnace, causing it to rise as steam into the steam drum, which is subsequently circulated to where it is needed. A schematic representation of a water-tube boiler can be seen in Figure 44.

Figure 44: Schematic diagram of a water-tube boiler



Water-tube boilers can be used in marine and locomotive applications, as well as for industrial applications which require low to high pressure steam. This type of boiler is often be used in power station applications where high temperature and high pressure steam is used.

Potential for improvement

Similar to blow-down improvement practices for cooling towers.

Market trends

All steam generating boilers are classified under PRODCOM category 28.30 *"Manufacture of steam generators, except central heating hot water boilers"*. Water-tube heaters are classified under the PRODCOM as those that produce steam at a rate equal to or below 45 tonnes/h[44] and those that produce steam at a rate of more than 45 tonnes/h (28.30.11.30)[45].

Table 53 shows the European production data extracted from the database between 2004 and 2007. It appears that boilers that produce steam at a higher rate have experienced a drastic fall in production between the 2004 and 2005 period. From this data it has been deduced that the production of the higher rate boilers has reduced by

[44] PRODCOM code 28.30.11.10
[45] PRODCOM code 28.30.11.30

65% and lower rate boilers by 14%. Without specific data on imports and exports, it is difficult to determine whether this decrease indicates a declining market in Europe.

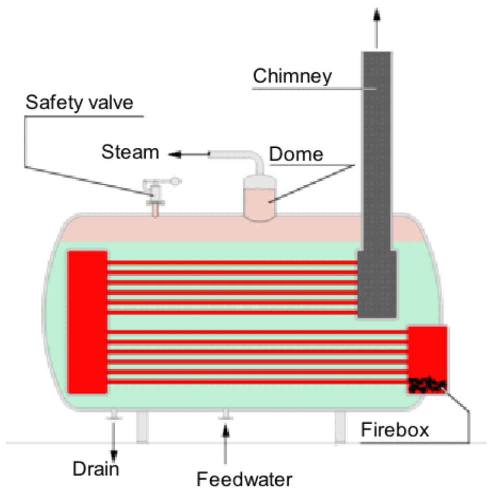
Table 53: Water-tube boiler units produced in EU-27 between 2004 and 2007

Steam Generation Equipment	2004	2005	2006	2007
Water-tube boilers with a steam production > 45 tonnes per hour (excluding central heating water boilers capable of producing low pressure steam)	8,000	3,563	2,980	2,782
Water-tube boilers with a steam production <= 45 tonnes per hour (excluding central heating hot water boilers capable of producing low pressure steam)	4,453	4,926	4,084	3,810

Fire-tube boiler

Definition: In contrast with water-tube boilers, fire-tube boilers are vessels partially filled with water that is heated by a series of tubes containing gas that has been heated by a furnace (also known as a fire-box). The water is converted into low-pressure steam and circulated through a system. A schematic representation of a fire-tube boiler can be seen in Figure 45.

Figure 45: Schematic diagram of a fire-tube boiler



Fire-tube boilers are typically used for transportation relying on steam (locomotive and marine applications). As they produce low pressure steam, they have been used more recently for heating of buildings and in different industrial processes. In order to maintain the pipe work in these boilers, they must be bled periodically to remove TDS. Water consumption is therefore dependent on the frequency of blow-down carried out.

Potential for improvement

Similar to for blow-down improvement practices for cooling towers.

Market trends

At present, information on market trends for fire-tube boilers does not seem to be available, other than in aggregated form (Table 54). This table excludes water-tube boilers and indicates a significant downward trend (a decrease of approximately 48%) for vapour generating boilers. However, it is not clear what other types of boilers are included in this category. As well as fire-tube boilers, other types (for example, those specific to marine applications) may be included which do not fall within the scope and may be influencing this downward trend.

Table 54: Vapour generating boiler units produced in EU-27 between 2004 and 2007

Steam Generation Equipment	2004	2005	2006	2007
Vapour generating boilers (including hybrid boilers) (excluding central heating hot water boilers capable of producing low pressure steam, watertube boilers)[46]	73,888	57,962	37,913	38,398

3.2.3.3 Cleaning equipment

Industrial cleaning devices are often generic as they may be used in various industrial scenarios. The most commonly used water consuming devices for industrial cleaning have been identified and listed below.

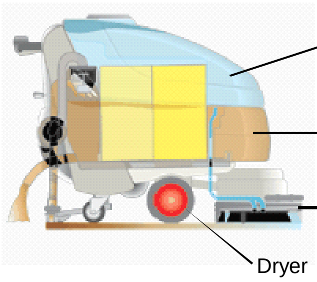
- **Scrubber Driers**

Definition: A scrubber drier is a combined automatic cleaning machine that includes types such as pushed (walk-behind), self propelled, or ride-on. They may be used for a range of floor cleaning applications in both industrial and commercial settings. Each machine comprises a scrubbing unit at the front, a rear drying unit (which includes a suction device known as a squeegee), a tank for a water-detergent solution (solution tank), and a tank for collecting dirty water (known as a recovery tank). The water-detergent solution is dripped onto the brushes as the machine moves forward. Simultaneously, the squeegee aspirates the solution, dirt and debris, and conveys them into the recovery tank. A cross-section of a typical walk-behind scrubber-dryer is shown in Figure 46.

Scrubber driers may be used for a range of floor cleaning applications in both industrial and commercial settings. The amount of water consumed is dependent on what detergent dilution the user wishes to apply. The amount of water used is also dependent on the cleaning efficiency of the scrubber drier and the strength of the solution used. The latter depend on the type of cleaning job being carried out (e.g. the type of floor covering).

[46] PRODCOM code 28.30.11.50

Figure 46: Cross-section of a scrubber drier (*Comac SpA, 2008*)



Potential for improvement

The efficiency of a scrubber drier is dependent on the cleaning efficiency of the product. This may be dependent on the detergent used and the type of debris being removed. There may be a potential for recycling water in the recovery tank for re-use during cleaning, although in some industries (e.g. food industry) this may not be an option.

Market trends

Data for the production, trade and sales of scrubber driers is presently unavailable.

Pressure washers

Definition: A pressure washer is a mechanical device that relies on a high pressure jet of water to clean surfaces. Pressure washers may be supplied as either electric or fuel powered (diesel, gasoline or gas) units. Fuel powered units are often able to deliver a higher pressure; those that deliver a water jet at extreme high pressure are available for use in industrial cleaning. These products are available as static or mobile units (a) and (b)), and may deliver hot or cold water.

Figure 47: Mobile (a) and static (b) pressure washers

(a)

(b)

Pressure washers may be used to clean surfaces in many different types of industries. The amount of water consumed by the product is dependent on the amount of pressure used. The pressure may be controlled by the user and is dependent on the type and adhesiveness of the debris to be cleaned up by the product.

- **Potential for improvement**

The efficiency of pressure washers can be raised somewhat if the temperature and pressure of the water jet is increased. This contributes to reducing the cleaning time required, thus saving water. This alternative may, however, not be possible, where temperature sensitive or fragile equipment needs to be cleaned. Furthermore, the use of detergents can also lead to a reduction in cleaning time and water consumption. Once again, this is dependent on the type of equipment that needs to be cleaned and may in fact be more environmentally damaging (e.g. where toxic detergents are used).

- **Market trends**

Data for the production, trade and sales of pressure washers could not be found. It is worth noting that these products require little or no detergent use. The drive for using less toxic products for cleaning in industry (in the interest health, safety and environment regulations) may increase the popularity of these products.

- **Steam cleaners**

Definition: Industrial steam cleaners are devices that produce steam within an inner tank heated by a boiler. The steam is emitted at high pressure and is used to dislodge dirt and grime. The high temperature of the steam is also believed to kill micro-organisms, making it an ideal cleaning device for application in the food and beverage industries. They may be fuel or electric powered (Figure 48 (a) and (b)), and some devices are provided with an automatically filling water tank.

Figure 48: Fuel powered (a) and electric powered (b) vapour steam cleaners

(a) (b)

Steam cleaners may be used in a variety of industrial settings for cleaning equipment and other surfaces. The amount of water consumed is dependent on the cleaning efficiency of the equipment and steam pressure. Heavy duty equipment is often used in commercial and, more recently, industrial applications.

Potential for improvement

The efficiency of steam cleaners can be increased by raising the power output, thus increasing the pressure at which the equipment operates. Maintaining a high temperature also increases the cleaning efficiency of the equipment as it facilitates the removal of stubborn debris. Super-heated steam cleaners may require less time to clean an area, and consume less water as a result.

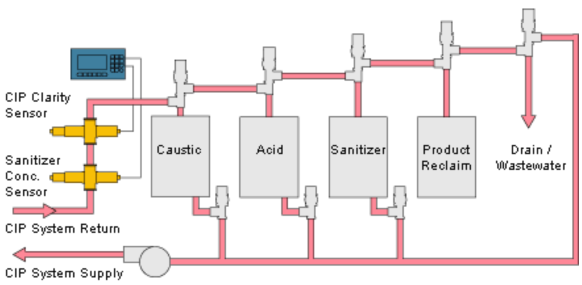
Market trends

Data for the production, trade and sales of industrial steam cleaners could not be found. As these products require little or no detergent use, they too may increase in popularity as health, safety and environment regulations call for less use of toxic cleaning products.

Automated cleaning in place devices

Definition: Cleaning in Place (CIP) devices, are industrial systems designed for automatic cleaning and/or and sterilisation of the interior surfaces of pipes, tanks, process equipment, and associated fittings, following a process or production cycle. They are particularly useful in the industrial sector as equipment can be cleaned without having to disassemble factory equipment. Industries that rely heavily on CIP are those which require high levels of hygiene such as the food, beverage and pharmaceutical industries. CIP systems may be produced as factory installations (static) or mobile equipment, both of which are connected to a piped water supply. Figure 49 shows a schematic diagram of a CIP system.

Figure 49: Schematic representation of a typical CIP system (*Optek, 2008*)



The different cleaning cycles are dependent on the program selected by the user. Below is a list of the typical programs chosen and the water using steps associated with each one:

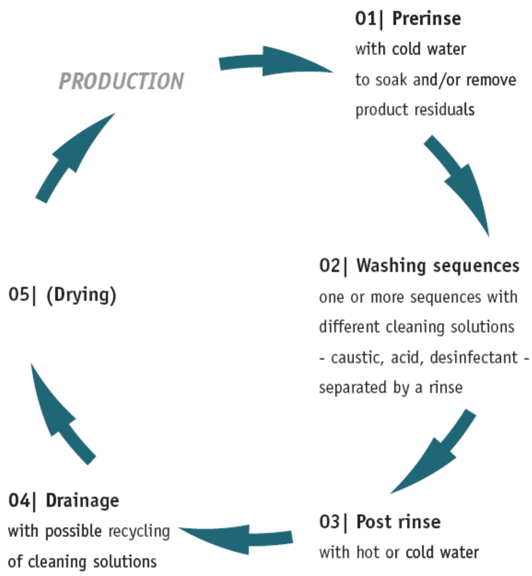
- *Rinsing:* Rinsing only
- *Cold-CIP:* Pre-rinsing and washing cycle rinsing
- *Hot-CIP*: Pre-rinsing , hot water and rinsing

- *Full-CIP*: Pre-rinsing, caustic solution, hot water and rinsing

Potential for improvement

CIP equipment undergoes a series of cycles which rely on water use, particularly the pre-rinse, washing, and post-rinse cycles. Being closed systems, there is opportunity to save water, providing the system is set up to clean as efficiently as possible. Some CIP systems are able to recycle rinsed water for a subsequent caustic wash, thereby increasing efficiency. Adequate maintenance and flow monitoring may also increase water use efficiency of these systems. Technology is also available which monitors the cleaning efficiency of the CIP system and control cleaning cycles to ensure optimum function of the equipment. This in turn may help to improve water efficiency. The case study in box 1 below illustrates how monitoring of CIP systems may be employed in the industrial setting to increase water use efficiency. Figure 50 illustrates a typical automated CIP cleaning cycle.

Figure 50: A typical automated CIP cleaning cycle (*Packo, 2008*)



Market trends

Data for the production, trade and sales of CIP systems could not be identified. Existing and future hygiene regulations may have an influence on market trends related to this type of equipment.

Box 1: Coors Brewers Ltd – Optimisation of the Yeast Handling CIP Systems

At a glance:

- 37% reduction in water-use;
- Additional savings in chemical costs and CO_2 emissions;
- Nine-week payback period.

Coors Brewers produces many of the UK's top beer brands – it has a 20% share of the market. Coors took on the project to see if their automated cleaning system for cleaning tanks and pipelines was effective and if it met their cleaning specification. Coors implemented a data-monitoring unit (In-Site Management Information System) in their outlets. This interfaced with the individual site's automated CIP system to record all actions that were carried out during cleaning. The operation was monitored and recorded continuously over a period of two months.

The In-Site system produced several reports as each clean was completed. These include the cost of utilities involved in the process, verification of quality standards (based on pass or fail) and the environmental impact of each clean in terms of the electrical energy used. Such detailed monitoring enabled Coors to see how they could improve the existing programme sequences.

The subsequent changes created many water-efficiency benefits, including: optimisation of the demand for water (and thus reduction in effluent discharge); optimisation of the use of chemicals; recycling of the last cycle of rinse water as pre-rinse water; and identification of system errors – eliminating aborted cleans and re-starts further reduced the demand for water. As a result of these actions, the use of mains water was reduced by 54%. Overall, water use decreased by 37%. The project paid for itself in nine weeks. The project also resulted in additional savings in CO_2 emissions (by 132 kg per year) and chemical requirements. Coors Brewers Ltd now has 62 separate CIP systems made up of 91 individual CIP channels. They aim to identify savings of £10,000 per year on each channel.

Source: *The Environment Agency Water Efficiency Awards, 2005*

3.2.4. Water performance assessment of WuPs in industry

3.2.4.1 Cooling equipment

➢ **Standard products**

Water consumption by industrial cooling towers depends on various factors – type of industry, amount of water needed to cool per unit of time, maintenance practices, etc. This sub-section will focus on cooling towers used in the electricity generation sector. The type of electricity generation can have an influence on the consumption of cooling water (Table 55).

Table 55: Cooling tower water consumption by type of thermoelectric energy generation plant (*Goldstein et al., 2002*)

Generation type	Water consumption (l/kWh)
Fossil/biomass/waste	1.82
Nuclear	2.73
Natural gas/oil combined-cycle	0.68
Coal-petroleum residuum-fuelled combined cycle	0.76

The units used to measure water consumption of cooling towers may also differ depending on the type of industry they are employed in. In the steel industry, for example, consumption may be measured according to the amount of steel produced (e.g. l/ton of steel). It is difficult, therefore, to find a universal measurement based on productivity. Furthermore, more investigation is needed to determine the difference in consumption between different types of cooling towers (e.g. natural vs. mechanical vs. hybrid draft or cross-flow vs. counter-flow). Such information is not readily available and seldom investigated across different types of industries.

- **Water-efficient alternatives**

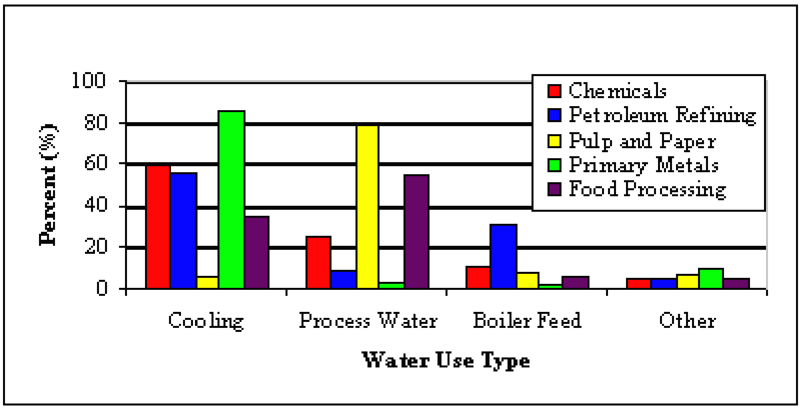
Three types of cooling technologies could be considered alternatives to conventional cooling towers in terms of reducing water consumption. This includes once-through cooling, cooling ponds, and dry cooling. In the case of nuclear-fuelled power generation for example, the use of once-through cooling can reduce water consumption from 2.73 l/kWh to 1.51 l/kWh, i.e. more than 50% reduction. However, once through cooling is dependent on the presence of a large body of water nearby. Discharge law may also restrict the temperature at which water is returned and thus this option may not be available to some industries. Although not often used, cooling ponds may be another alternative. However, again this is only feasible if a large lake or pond is available for cooling and this may not be an option for many industries.

Another option is the use of dry cooling technology, where little or no water loss occurs as the cooling system relies on the use of powerful large fans, instead of relying on evaporative processes or water based heat-sinking. This process can reduce water consumption to as little as 0.15 to 0.25 l/kWh – by approximately less than 10% (*World Nuclear Association, 2008*). However, up to 1.5% of the plant's electrical output is needed to operate this system, resulting in a loss of productivity. A water-cooled condenser circuit may be used as an alternative to this, where the boiler system is cooled by air flow through a closed circuit and heat is allowed to dissipate through the surrounding air, thus using no water. This system of cooling is, however, less efficient, although the energy consumption is considerably lower at 0.5% of the plant's electrical output.

3.2.4.2 Steam generating equipment

Quantitative data for boiler water consumption is scarce and difficult to source. Although water consumption should be viewed as a requirement for plant operations, it may be best approached by modifying management practices, which can contribute significantly to reduce total water consumption. Moreover, of the highest water consuming steps in industry (cooling, processing, and boiler function), this is often the least water consuming step in industrial processes (Figure 51). Reducing boiler water consumption may therefore not be of as high a priority as for cooling and processing.

Figure 51: Types of water use by different industries (*Ellis et al., 2001*)



3.2.4.3 Cleaning equipment

- **Scrubber driers**

  - **Standard product**

Water is often used by a scrubber drier mixed with detergents. The actual ratio of water to detergent can vary greatly depending on the job that must be carried out and the cleaning efficiency of the detergent. Water consumption by this type of equipment can range from as little as 0.4 l/min to as high as 9 l/min. The amount of water consumed in total is also dependent on the size of the area the scrubber drier is able to clean in a set amount of time. Some scrubber driers are capable of cleaning areas of more than 5000 m^2 per hour, and thus would require less solution than those which are only capable of cleaning smaller areas within the same space of time. The actual water consumption is also dependent on other factors such as the type of debris to be cleared up, operator skill and the type of surface that needs cleaning.

  - **Water-efficient alternatives**

Some of the major scrubber drier manufacturing companies are beginning to introduce technology that, along with optimising or eliminating detergent use, also contribute to reducing water dosage by this type of equipment. Two examples include the Nilfisk EDS dosage technology and the Tennant ec-H_2O electrically converted water scrubber driers.

These types of technologies replace the traditional manual method of calculating how much detergent is necessary for a certain cleaning application, therefore increasing cleaning efficiency (and thus decreasing overall water consumption). The system also meters the amount of water required and is reportedly able toreduce total water consumption by as much as 50% (*Nilfisk, 2006*).

The electrical water conversion system uses an entirely different and innovative method. Instead of using detergent, the water in the tank is oxygenated initially and subsequently charged in a water cell. The then positively and negatively charged water particles are used to clean the floor, and it is this charge that enables it to work much like a detergent solution, in order to break up debris and remove it from the floor's surface. This type of technology is reportedly able to reduce total water consumption by as much as 70%. (*Tennant, 2008*)

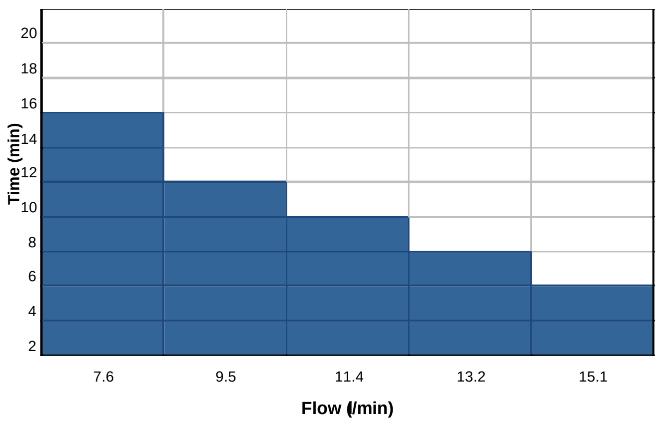
- **Pressure washers**

  - **Standard products**

Pressure washer water flow can fall within a range of 5.3 to 30.3 l/min. However, a range from 11.4 to 18.9 l/min is more typical of this type of equipment. Figure 52 demonstrates the effect water flow has on the amount of time needed to clean a set area. As expected, the greater the water flow, the faster an area of a certain size may be cleaned.

It is important to note that the above figure gives only a general comparison of cleaning times as actual cleaning times are dependent on other factors such as operator skill, detergent use, the adhesiveness of the debris, etc. Furthermore, the cleaning efficiency of a pressure washer is dependent not only on the water flow but also the pressure and temperature at which the equipment is functioning. It stands to reason that the higher the pressure and temperature, the quicker an area may be cleaned, and therefore the less water and detergent will be needed.

Figure 52: The effect of water flow on time required to clean a specified area (*Northern Tool, Date 2009*)



  - **Water-efficient alternatives**

Alternative technologies are available which may be used in the place of pressure washers for some industrial applications. Blast cleaning devices, for example, rely on mechanical forces to remove dirt and debris, and use no water at all. These devices may use media such as sand/grit, calcium carbonate (soda), carbon dioxide (dry ice), and other solid media. Blast cleaning devices could be considered BATs for industrial cleaning applications. However, some types may not be appropriate for certain industries and the cost-effectiveness of using such equipment in place of pressure washers may be an issue to some end users.

- **Steam cleaners**

1. Standard products

Standard steam cleaning products can consume between 6 and 23 l/min. Some of the same factors that govern the efficiency of pressure washers are also applicable to steam cleaners. The defining difference between the two products is that the water used by steam cleaners is heated to a much higher temperature and the pressure used is much lower. Depending on the type of surface being cleaned, the performance of the two products in terms of water consumption may be comparable.

2. Water-efficient alternatives

An alternative technology to conventional steam cleaners are 'dry steam' cleaners. Dry steam cleaning machines use a much lower amount of superheated water which produces steam with a very low moisture content. The high temperature of the dry steam sanitises surfaces and dislodges debris much like a conventional steam cleaner. Some dry steam models can have a water consumption level of as low as 0.1 l/min (*Weidner Cleaning, 2008*).

3.2.4.4 Overview of water consumption of different industrial WuPs

In comparison to both residential and commercial water consumption figures, those available for industrial water consumption are either scarce or too specific to a type of industry. In terms of cooling tower water consumption, the average use is dependent not only on the type of industry, but also on the type of processes being cooled. As shown earlier, in the electricity generating industry, fuel type may influence the total water consumption by the cooling tower.

The water consumption of steam generating equipment, as with cooling towers, is also dependent on the type of industry they are employed to be used in. Data for these types of products is currently unavailable and therefore further investigation would be needed to determine water consumption figures. In relation to cleaning equipment, a summary of the average water consumption for these product types can be seen below in Table 56.

Table 56: Summary of WuP water consumption by industrial cleaning equipment

WuP	Average water consumption per use
Scrubber Driers	0.4 – 9 l/min
Pressure Washers	5.3 - 30.3 l/min
Steam Cleaners	6 - 23 l/min

Although average consumption data is available for different types of equipment, the typical water consumption largely depends on factors such as the time needed to clean an area, the type of surface being cleaned, operator skill, and other individual factors such as type and concentration of detergent used (for scrubber-driers), temperature (as for steam cleaners and pressure washers), and pressure level (in the case of pressure washers). The figures for average daily consumption of industrial WuPs will also depend on the type of business. An investigation into use patterns would be necessary in each industry to determine an overall average daily consumption pattern for each type of product.

3.3. WATER USE IN AGRICULTURE

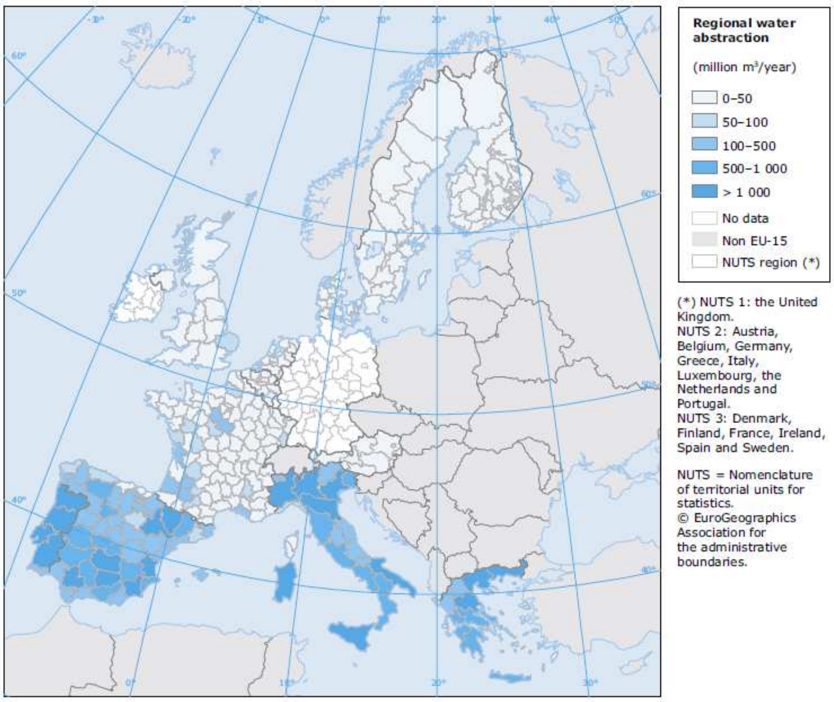
3.3.1. OUTLOOK OF WATER USE IN AGRICULTURE

Abstraction of water for agricultural purposes is one of the major sources of water consumption and is mainly driven by the water demand for irrigation. The water abstraction for irrigation in Europe for the period 1997-2005 represented about 24.3% of total abstraction and more than half of its consumptive uses (*Eurostat, 2005*). As illustrated in Figure 53, agricultural water use varies significantly across MS and even across regions within same MS. Agriculture is much more water consumptive in southern regions than in northern MS which highlights the crucial influence of climatic conditions on agricultural water use.

3.3.1.1 Drivers of agricultural water use

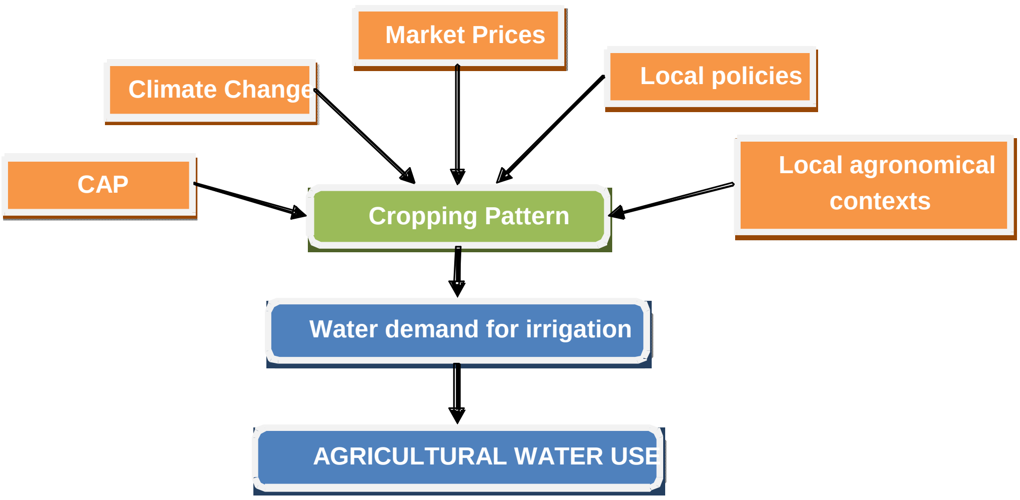
Water for irrigation is the main driver for water demand in agriculture. Many factors can influence the water demand for irrigation as illustrated in Figure 54. Of crucial importance are climatic conditions and in particular the amount of rainfall. Indeed, water availability at some crucial vegetative stages of crops has a direct impact on the final yield. Different crops have different water needs, thus cropping pattern a major impact on water demand for irrigation. However, the evolution of cropping patterns in Europe is subject to uncertainty, in particular regarding the evolution of CAP, production of biomass, biofuels, and other agri-resources, and climate change (*Dworak et al., 2007*).

Figure 53: Regional water abstraction rates for agriculture (million m³/year) during 2000 (*European Environment Agency, 2005*)



Source: Community survey on the structure of agricultural holdings (FSS), Eurostat combined with information from OECD/Eurostat questionnaire.

Figure 54: Main determinants of water use related to agriculture

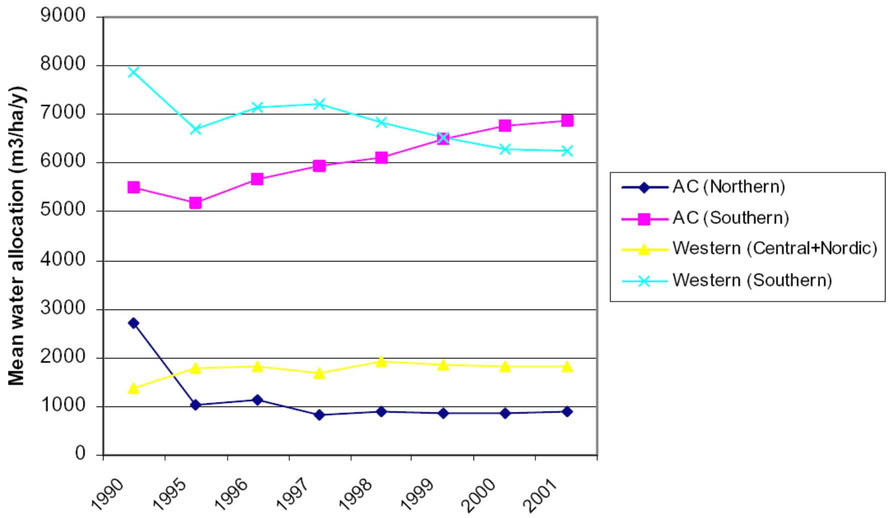


3.3.1.2 General trends in agriculture related water abstraction

The average water allocation for agriculture decreased from around 5 499 to 5 170 m³/ha/year from 1990-2000 (Figure 55). While irrigation is well developed and in progression in Southern countries (Greece, Cyprus, Malta, Spain, France, Italy, Portugal), it is stable and decreasing elsewhere.

The data used in establishing these calculations has a high degree of uncertainty, and thus should be interpreted with care and used for understanding a general trend instead of absolute numbers.

Figure 55: Trends in water use for irrigation (*Lallana et al., 2004*)



3.3.1.3 Common irrigation techniques[47]

➢ **Surface irrigation**

The oldest and most common way to provide water to crops is flooding fields by simple gravity. Water is usually conveyed through a canal system and distributed into furrows, border strips or basins, often associated with a system of terraces. Because of high evaporation and infiltration losses, surface irrigation is considered to be the least efficient technique of irrigation.

➢ **Sprinkling irrigation**

This more recent technique consists of conveying pressurised water to sprinklers which reproduce a rain-like input. Type, size, and form of sprinklers vary. Sprinkling irrigation is particularly used by cereal growers; because it can cover large areas with better cost effectiveness than localised irrigation. Run-off due to inadequate input can be the main cause of water losses. Four common types of sprinkling equipment used arev presented below:

[47]Descriptions based on R. G. Evans. Irrigation Technologies. USDA Available at: http://www.sidney.ars.usda.gov/Site_Publisher_Site/pdfs/research_pdfs/irrigation/general%20irrigation%20systems-mondak.pdf, "Irrigation techniques". USGS. http://ga.water.usgs.gov/edu/irmethods.html. and "The Irrigation Association". http://www.irrigation.org

1. **Centre pivot irrigation** – This type of equipment consists of a long pipeline (or segments of pipe) supported by a wheeled frame. The frame is often equipped with wheels and allows the system to rotate around a flat area. Water is supplied at the central pivot to a series of sprinkler heads or nozzles which hang down from the central pipe. Centre pivot systems may also comprise a spray gun at the tip to increase the radius of the area irrigated. Centre pivot systems are said to be among the most efficient type of sprinkling or spraying irrigation, with high application efficiency and uniformity. However these systems are often costly to purchase and install, and therefore require a high initial investment. In recent years, this type of technology has seen some developments such as the introduction of Low Energy Precision Application (LEPA) systems which are said to increase application efficiency to as high as 95 to 98%.

2. **Linear lateral irrigation** – This type of equipment is very similar, the main difference is that instead of travelling radially, the equipment moves in a straight line across the field and water is supplied by a large hose at one end. As with centre pivot irrigation, linear lateral systems can also use LEPA technology to improve efficiency.

3. **Traveller spray boom irrigation** – Usually constructed as a series of pipes supported by a single wheeled frame at the mid-point or a single spray gun supported by a set of wheels. Water is supplied by a large hose to a set of sprinklers or sprayers. Instead of moving in a radial pattern, this type of system is able to move in a straight line. Unlike larger system, traveller spray booms are portable and can be used in smaller or oddly shaped fields. It has an average irrigation efficiency of approximately 80% and is often used for

supplementary irrigation. However, some problems can occur where soil type can lead to inadequate uniformity.

4. **Solid set irrigation** - Solid set irrigation involves a series of permanently fixed pipes (above ground or buried) which deliver water to sprinkler heads or sprayers above ground. Unlike the above equipment types, the equipment remains in place throughout the irrigation season, although sprinkler heads are often able to rotate. These systems are used more frequently for orchards and other high value crops, as well as recreational areas such as golf courses and large gardens. This type of equipment can also have other uses such as protecting crops from frost or crop cooling.

- **Localised irrigation**

Delivering water close to the roof zone is the aim of this most recent technique of irrigation. This can be done by means of a surface network of polyethylene pipes equipped with drippers, micro-sprinklers or spitters with the appropriate management, and can significantly reduce run-off and evaporation. Localised irrigation is generally considered as the most efficient technique. However, there are disadvantages, including the considerably higher cost of this technique, maintenance requirements, and the fact that it is not suitable for large fields where ploughing is practised. Drip or trickle irrigation is the most common type of this kind of system. Drip irrigation delivers water near or directly at the root of crops. As the name suggests, water is delivered in drops. Instead of dripping heads, micro-spray heads may be used to spray water in a similar way to solid set spraying systems, but over a considerably smaller area. Drip irrigation can also be permanently installed underground (sub-surface drip irrigation). The low pressure delivery of water and proximity to the soil or plant root helps to ensure that water is not lost due to wind or evaporation. As such, it is considered to be one of the most water efficient types of irrigation systems.

3.3.1.4 Irrigation technique pattern in Europe

Table 57 summarises the most common irrigation equipment used in different MS.

Table 57: Type of irrigation in some MS (*Baldock et al., 2000*)

MS	*Dominant technique of irrigation*
Greece	Sprinkling dominant. Localised irrigation increasing
Spain	Surface irrigation dominant
Portugal	Surface dominant. Sprinkling and localised irrigation increasing
Italy	Surface dominant. Sprinkling and localised irrigation increasing
France	Sprinkling dominant
United Kingdom	Sprinkling dominant
Germany	Sprinkling dominant
Netherlands	Surface, Sprinkling and localised irrigation
Belgium	Sprinkling dominant
Austria	Sprinkling dominant
Denmark	Sprinkling dominant
Luxembourg	Sprinkling dominant
Sweden	Sprinkling dominant
Finland	Sprinkling dominant
Ireland	Sprinkling dominant

This table shows that surface irrigation is practised mainly in Mediterranean countries (Spain, Italy, and Portugal). Overall, the most popular irrigation technique appears to be sprinkling irrigation. However, Table 57 is based on 1999 data and significant changes in irrigation patterns might have occurred since then. For instance, in Spain, the implementation of a National Irrigation Plan (PNR) in 2002 deeply transformed the irrigation patterns of the country. In fact, localised irrigation is now more widespread than surface irrigation (44.7% of area irrigated against 33.2% in 2007) (*Barbero, 2005*). In France, in 2001, drip irrigation represented 5% of the irrigation systems (*Ruelle et al., 2005*).

3.3.2. SCOPE DEFINITION

Due to the variety of agro-economical contexts and the dominant impact of irrigation management on water consumption, and the differing definitions of irrigation efficiency, it is quite difficult to compare the efficiency of different irrigation equipment. In fact, it appears that the equipment itself has limited influence on the overall efficiency of irrigation, and thus will not be tackled in the scope of this study. The following sub-section explains the reasoning behind this scope definition.

3.3.2.1 Water use efficiency of irrigation equipment

➢ **Different indicators of irrigation efficiency**

One of the complexities of irrigation is the fact that different indicators are used to assess the water performance of irrigation systems. In fact, the term *irrigation efficiency* refers to several different definitions, which often leads to confusion (*Know et al., 2007*). For example, yield-based (crop yield per cubic metre of water used) or profit-based (profit per millimetre of irrigation) approaches exist (*Bos, 1980*), while another definition focuses on the amount of water actually used by the crop. More than 30 different definitions of irrigation efficiency are currently in use (*Edkins, 2006*).

➢ **Measuring the water use efficiency of irrigation equipment using the *crop water-use approach***

The crop water-use approach measures overall water use efficiency of irrigation by calculating the percentage of diverted water that is actually used by the crop. This is measured by two indicators: conveyance efficiency and field application efficiency.

- **Conveyance efficiency**

This refers to the percentage of diverted water from the source that is actually delivered to the field. Conveyance efficiency depends on the type of conveyance equipments and its level of maintenance. For instance, pressurised networks are usually considered more efficient than open channel where evaporation can induce water losses.

Although significant water savings could be achieved by improving the conveyance efficiency (*Dworak et al., 2007*), this aspect is not addressed by this study.

- **Field application efficiency**

Field application efficiency is the ratio between water used by the crop and the total amount of water delivered to the fields. Evaporation, run-off or deep percolation due to an inadequate application of water are the main causes of reduced field application efficiency.

Figure 56: Attainable field application efficiencies of the main irrigation techniques (*Ruelle et al., 2005)*

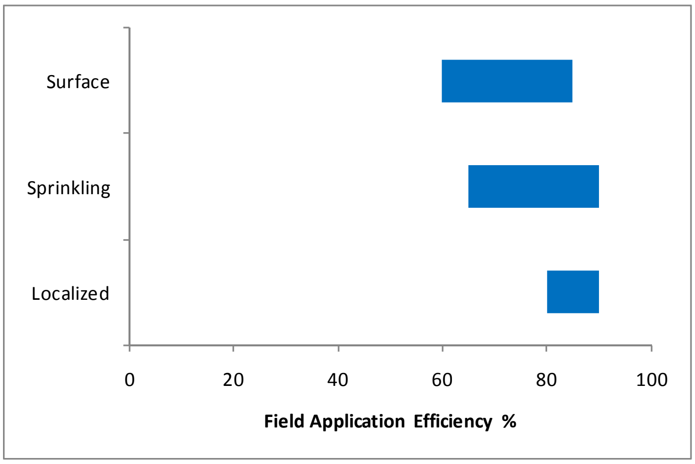


Figure 56 gives the potential field application efficiency that can be achieved for the most common techniques of irrigation. While average application efficiency is higher with localised irrigation, high levels of efficiency can also be achieved with surface or sprinkling irrigation. There are many factors which affect field application efficiency. Of these, two key aspects have the greatest influence – irrigation system design and system management (*Edkins, 2006*). Efficiency losses can occur due to many external factors; Table 58 shows some of the factors which can contribute to loss in efficiency of spray irrigation systems in New Zealand.

Table 58 – Expected water losses on spray irrigation systems

Source of loss	Range	Typical
Losses from open races	0-30%	10%
Leaking pipes	0-10%	<1%
Evaporation in the air	0-10%	<3%
Blown away by wind	0-20%	<5%
Watering non-target areas	0-5%	<2%
Interception by plants	0-3%	<2%
Surface runoff	0-10%	<5%
Uneven application (non-uniform distribution)	5-30%	15%
Excessive application depth	0-50%	10%

According to these figures, the greatest water losses are due to open races, uneven application and excessive application depth. Excessive application is usually due to inflexible system design and inadequate management. For example, during wet weather, rainwater can be used for crop irrigation. However, neither the occurrence nor the amount of rain can be predicted or controlled, which makes it difficult to adjust the irrigation system accordingly. It is also worth noting that with regard to excessive application, it is not the rate at which the equipment delivers water that determines whether the application amounts are efficient, but rather the immediate water needs of the crop throughout the day, i.e. whether more water is required or too much is being delivered. Choosing the right type of equipment and allowing some flexibility in irrigation design could help mitigate excessive crop watering. The rate of water application needed is both a function of the equipment and system design.

Uneven application is usually due to inadequate uniformity in the distribution of water (sometimes influenced by wind or ineffective sprinkler pattern), or by excessive application rates, which can cause changes in the nature of the ground. Research in the UK has shown that even though some systems are potentially more efficient than others, their *actual* irrigation efficiency can be lower than their seemingly inefficient counterparts in terms of application uniformity (*Know et al, 2007*). Although some studies have shown that the use of trickle irrigation has led to increased efficiency and yield, this did not apply for potato crops, due to a lack of uniformity which is needed for this type of crop. It was concluded that the level of uniformity is crucially dependent on management of on-farm irrigation, as well as the type of crop being grown.

Other factors which influence design efficiency include the timing of applications, application depth, and water supply reliability. A high performance irrigation system must be designed to irrigate uniformly, with the ability to apply the right depth at the right time *(Bright et al., 2000).* Good design can result in 5-40% of efficiency improvements by correctly matching applications of water to soil water holding capacity, soil infiltration rates and by applying water uniformly (*Edkins, 2006*).

As mentioned above, some of these factors cannot be controlled by the design of the equipment alone. Whether a system is efficient or not also depends on how well the system is managed. Indeed, an inadequate irrigation scheduling, such as excessive application for example, can lead to considerable water wastage through evaporation, run-off or deep percolation ("*With poor management, even the most sophisticated system can result in water loss and inefficiency*" (*FAO, 1997*)). Irrigation management has been estimated to further improve the efficiency by 5 to 20% by applying the right depth of water in the right place and at the right time. Drip irrigation, for example, is considered to be one of the most efficient types of irrigation for fruit and vegetable crops (Rogers 1997). Therefore, selection of the system type, ensuring adequate water delivery, equipment maintenance can be seen as some of the most important aspects of irrigation efficiency.

- **Potential for improvement**

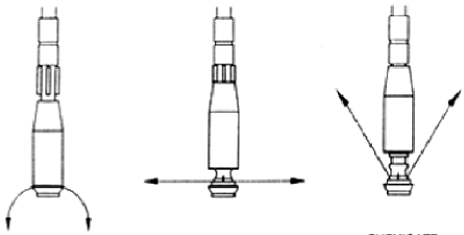
It has been previously suggested that a potentially significant improvement is seen in the use of sprinklers and drips designed to operate on low to medium water pressures.

Irrigation efficiency can be improved somewhat by lowering the pressure at which sprinklers emit water. This can significantly improve efficiency by reducing the amount of water that is lost through evaporation or blown away. As mentioned earlier, irrigation efficiency can be significantly improved with the installation of LEPA technology (Fipps, 1990). LEPA works on a low energy and pressure basis. Water losses with this system were estimated to drop from approximately 25 to 30% associated with conventional or high impact sprinklers, to a minimal 2 to 5% loss with LEPA sprinklers (Table 59). One of the unique features of this type of sprinkler head is that it is able to spray crops in a highly efficient bubble pattern. Although LEPA sprinkler heads are still capable of spraying in other patterns (Figure 57), the bubble spray feature is essentially what differentiates it from other types of low pressure systems (as well as functioning at an even lower pressure).

Table 59: Nozzle types, operating pressures and associated irrigation efficiencies (*Fipps, 1990)*

Nozzle type	Efficiency (%)	Operating pressure
High pressure impacts	60	90
Low pressure drop nozzles	80	40
LEPA	95	20

Figure 57: Spray patterns for LEPA sprinkler heads



One of the issues that can sometimes lead to favouring high pressure systems is that lowering the pressure can sometimes have an effect on the uniformity of irrigation, and therefore the irrigation efficiency. Higher pressure systems often provide greater uniformity, however recommending one sprinkler type over another is often difficult as many sprinkler variations are available and several other variables can affect irrigation efficiency (eg nozzle size, soil conditions, topography, plant material, and spacing) (*Koch, 2003*).

Although using lower pressure sprinkler systems provides some improvement in efficiency, some studies have shown that certain localised irrigation systems (especially sub-surface drip irrigation) provide even greater improvements (*Schneider, 2001*).

3.3.2.2 Comparisons of different irrigation techniques and equipment

Another criterion used to evaluate irrigation systems is irrigation uniformity. This refers to how evenly water is distributed across the field. The degree of uniformity influences the efficiency of irrigation. However, deficiencies exist in the methods of measurement and reporting of irrigation uniformity for different technologies. Thus, the comparison of measured uniformity for different irrigation technologies is often misleading. However, comparison of uniformity of application of different equipment within a given technology is possible. Nevertheless, the importance of agronomic factors and management of irrigation would undermine this type of comparison (*University of California Centre for Water Resources, 2005*).

Few studies specifically compare the efficiency of water use between different irrigation techniques or equipments. Therefore, their results cannot be extrapolated because they depend greatly on the agronomic contexts and irrigation management. A United Kingdom study confirms that the levels of efficiency attained in practice depends more on the suitability of a particular crop and soil on which it is grown to a particular irrigation method rather than the method of application *per se (Know et al., 2007)*. The selection of appropriate equipment according to crop type and soil characteristics, along with the careful design of the irrigation system, can have a significant influence on the efficiency of irrigation.

3.3.2.3 Overall water consumption approach

For the management of irrigation systems, farmers have to take into account several parameters. The agro-economical context is of crucial importance. Crop needs, type of soils, and the climatic and topographic conditions can influence the amount of water that has to be supplied. Nevertheless, targeted yield and irrigation costs are also decisive.

The amount of water finally provided to a crop relies on the farmer's decision and depends on several factors **and the type of irrigation equipment has lesser influence on the amount of water provided to a crop.**

3.3.2.4 Switching irrigation techniques

A recent study showed that significant water savings could be achieved simply by converting surface irrigation systems into localised systems (*Dworak et al., 2007*). Indeed, at first sight, switching from surface irrigation to dripping systems seems relevant because of its higher application efficiency (if properly managed). This is even encouraged in Spain by a National Irrigation Plan (*Barbero, 2005*). Nevertheless, a change in technique must be made together with an appropriate change in management. Indeed, the use of a more efficient system could also lead to less carefulness in irrigation management. For instance in some regions of Spain, several studies showed that the adoption of drip irrigation did not ultimately lead to reduced application rates because it induced a change to more water-demanding crop patterns (*García, 2005; Berbel, 2005*).

Another obstacle to changing irrigation techniques is that there can be crop incompatibility with the associated irrigation techniques. While drip irrigation is well adapted to vegetable production, vineyards and orchards, such techniques cannot be applied on cereals, such as maize, wheat or barley.

What is emphasised here is the fact that agronomical contexts are so diverse and influence the level of agricultural water consumption so much, that it is risky to make general suggestions about the suitability. In addition, the choice of irrigation technique is also influenced by labour availability and productivity, access to financial resources and the existence of schemes for promoting the use of modern technologies.

3.3.2.5 Lack of certification on the performance of irrigation equipment

To date, there is no certification program dealing with the water performance of agricultural irrigation equipment. However, technical and research centres have developed methods to assess technical performance of irrigation equipments. For instance, a procedure to test the clogging sensibility of emitters for drip irrigation is under development at the "Laboratoire d'essais et de recherche des matériels d'irrigation" of the Cemagref[48]. They are planning to develop a label to assess the quality of irrigation equipment, and they are also conducting some research to select the most suitable irrigation equipment for wastewater spreading. Furthermore, new devices are available which control irrigation patterns according to the conditions throughout the day. These sensors monitor conditions such as plant need, temperature and rainfall in order to reactively control the amount of water discharged by the system, therefore avoiding over-watering. Although certification exists in the US for irrigation devices, it is used only for systems used in gardening and urban landscaping.

3.3.2.6 Conclusion: on WuPs in agricultural settings

Agriculture-related water consumption is mainly due to irrigation. As conveyance equipments falls out of the scope of this study, irrigation equipment could potentially be addressed here as WuPs.

However, as the previous sections illustrate, there are limits to this kind of approach which relies on comparing the efficiency of different irrigation systems. It is also important to highlight that although the type of equipment chosen can influence the water consumption, it is ultimately management, monitoring and design of the overall system which has the greatest influence on irrigation efficiency. Moreover, there are other methods of consumption control which are now being looked at to reduce water consumption in agricultural settings, including pricing, and setting restrictions on abstraction licenses.

Water efficiency standards are the focus of this study but through literature research and interviews with experts, it was evident that no certification mechanisms exist for irrigation equipment. This is not to imply that nothing can be done to increase water use efficiency in the agricultural sector. For instance, a quality labelling system could be

[48] The Cemagref is a frenchFrench public research institute dealing with land and water management.

a way to promote water efficiency among both farmers and manufacturers. But again, this should be combined with adequate training and information programs about irrigation management. However, the limitation of introducing such a label across all of Europe is that it may not be applicable to all MS. In MS with a regular supply of rainfall the introduction of restrictions would potentially have little effect.

Moreover, the type of equipment used is also dependent on the type of crop to be watered and in these cases equipment is not interchangeable. For example, one cannot employ drip or trickle irrigation in a large field where wheat is grown. On the other hand, centre pivot sprinkler systems cannot be used in areas such as fruit orchards and vineyards. A label that sets restrictions on the type of equipment as well as the water consumption could be counterproductive as it would not allow the flexibility needed to ensure the right equipment is used for the right application in appropriate areas.

3.4. PRIORITISTATION OF WUPS

The analysis of domestic water consumption and saving potentials clearly identifies key areas for action. Table 60 compares the water savings achievable by replacing standard products with water efficient products, and illustrates their contribution to the overall household consumption. Numbers in brackets rank the investigated WuP according to its contribution to the total household water consumption and the reduction achievable through high-efficiency models respectively. A 1 signifies the WuP with the highest and 6 the one with the lowest share in overall household water usage. Similarly, 1 indicates the highest saving potential and 6 the lowest. This comparison, for instance, shows very clearly that showers make up the highest share of household water use (33%). Their potential for reduction is, however, one of the lowest, at only 20%. Toilets are the second greatest water consuming product with 31% of the household share. They have the highest potential for reduction at approximately 53%, when compared to standard products. *Dvorak et al.* (2007) estimate reductions of up to 55%, which is in line with the figures presented here. In order to determine the significance of savings for each product in the context of a European household, the savings in relation to total water consumption has been calculated following the reduction of consumption for each product (Table 60). This provides a clear view of the significance of each product on the reduction of total household consumption and therefore provides a preliminary overview of which products should be considered high priority.

Table 60: Identifying priorities for action - Comparison of water consumption and saving potential

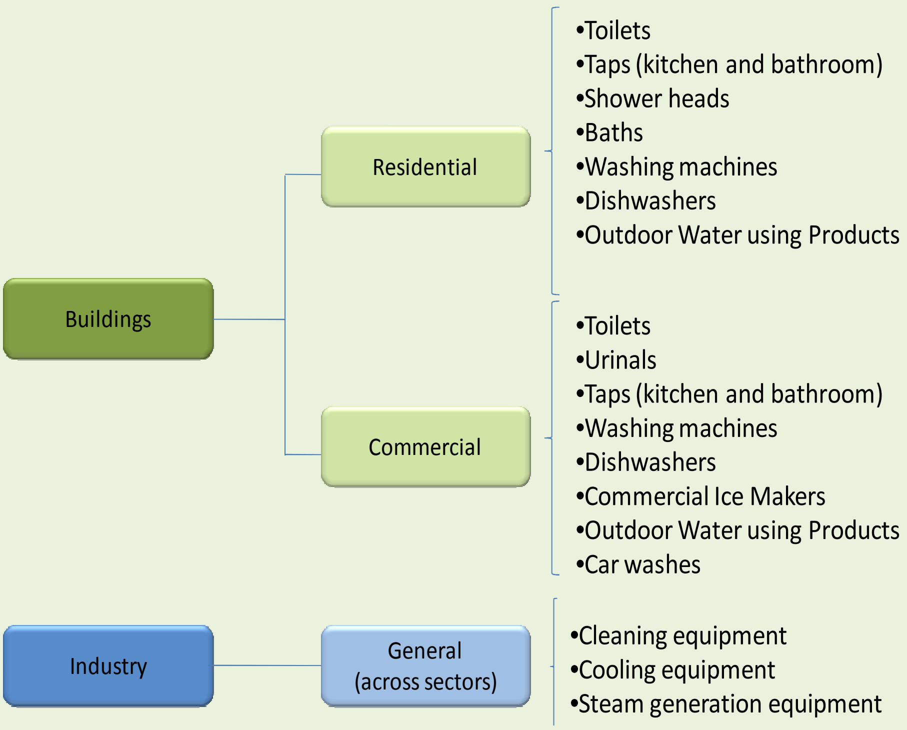
WuP	% of total household water consumption	% reduction standard vs. efficient	% reduction in household consumption	Rank
Toilets	31	53	13.7	1
Showers	33	20	6.2	2
Dishwasher	3	55	4.6	3
Washing machine	11	32	3.4	4
Taps	10	23	2.2	5
Baths	9	19	1.6	6
Outdoor	3	23	0.7	7

It is clear from the table above that although toilets have the second highest water consumption, replacing a standard product with water efficient products can contribute to a reduction of over 13% of household water consumption. This is followed by a reduction of 6.2% by replacing standard showers with water efficient types. Although replacing standard dishwashers and washing machines could potentially reduce total consumption by a considerable amount (4.6 and 3.4%, respectively), the estimations here have been based on ecodesign requirements. As these two product types are covered by this legislation, further instruments concerning water efficiency need not apply to these product types. Toilets, showers and taps should therefore be considered of highest priority.

3.5. CHAPTER KEY ELEMENTS

Summary of key elements regarding the identification and classification of WuPs

After taking into consideration different parameters such as use patterns, potential for improvement, water efficiency, and market trends of different devices and equipment known as “water-using devices” in different sectors, a number of different products are considered to be of greatest priority and included within the scope of the study. The figure below illustrates the WuPs that are included within the scope this study:



Building sector:

A large majority of products can be considered of high priority. The most important products in these domains are those used for sanitary, laundry, washing and outdoor applications. In particular, it has been estimated that WCs, showers, taps, washing machines and dishwashers contribute to 31%, 33%, 10%, 11% and 3% of average household water use respectively. Outdoor water consumption (e.g. garden irrigation, cleaning equipment, etc.) represents approximately 3% water reduction potential.

Regarding commercial buildings, the high frequency of usage in commercial buildings suggest targeting urinal, tap and WC replacement programmes at large commercial offices, schools, hospitals and hotels.

With most residential and commercial WuPs, there is some potential for improvement, especially for sanitation products (such as taps, toilets, showerheads, etc), meaning that the introduction of water efficiency standards in Europe could have a considerable impact on future water consumption.

Industry sector:

In comparison to household and commercial water consumption figures, those available for industrial water consumption are either scarce or too industry-specific. Therefore, this study focused on the products which are widely used across different industries, viz. cleaning, steam generation, and cooling equipment. In general, the typical water consumption of these equipments largely depends on factors such as the time needed to clean an area, the type of surface being cleaned, operator skill, and other individual factors such as type and concentration of detergent used (for scrubber-driers), temperature (as for steam cleaners and pressure washers), and pressure level (in the case of pressure washers).

It is noted that during the past few years, the overall water consumption in industry has fallen throughout Europe. This has mainly been due to the decline of industrial production, use of more efficient technologies with lower water requirements, and the use of economic instruments (charges on abstractions and effluents). This may suggest that a policy intervention in the case of WuPs of the industrial sector may not be as effective as household and commercial sectors.

Agriculture sector:

Agricultural WuPs have been excluded from the scope. The main reason for this exclusion is the difficulty that was encountered when determining how to measure the water efficiency of irrigation systems. Water efficiency is less dependent on the irrigation equipment than on the management practices employed by the end user. In particular, in comparison with irrigation management, the irrigation application equipment itself has little influence on the overall efficiency of water use. Indeed, it appears that with adequate irrigation management, in a convenient agronomical context, high level of application efficiency can be achieved with any suitable irrigation equipment.

Due to the variety of agro-economical contexts, the dominant impact of irrigation management on water consumption, and the differing definitions of irrigation efficiency, it is quite difficult to compare the efficiency of different irrigation equipment.

Therefore, to truly determine the water efficiency of irrigation systems, a study of the management practices and not the actual products would be required, which is not within the scope of this study.

4. REVIEW OF EXISTING STANDARDS

4.1. INTRODUCTION

The main objective of this chapter is to present detailed information on existing standards, schemes, programs, and other instruments that regulate the water performance of WuPs across Europe and beyond.

In this regard, it is important to highlight this research takes into account water efficiency requirements or specifications established on existing legislations, voluntary schemes, and labelling initiatives at the EU level, as well as technical standards (TS). Test standards and additional sector-specific procedures for product-testing have also been considered.

The analysis covers not only the 27 MS (at the national, regional and local level) but also other third countries that might have already developed and applied efficiency standards for WuPs, such as Australia and the United States.

This review is drawn from government reports, legislative texts, newspaper and online articles, and other published materials, including the official websites of the different schemes and labelling initiatives.

The review analyses the following aspects:

- Water-using devices that are covered by the standard
- Geographical coverage
- Objectives of the standard
- Technical specifications (e.g. water efficiency specifications)
- Type of scheme (e.g. mandatory or voluntary)

Furthermore, information was collected in order to be able to get a better insight into the efficiency and potential limitations of existing approaches, including:

- the water efficiency tests;
- the levels of efficiency required for each rating (“algorithms”);
- the minimum performance levels which products must meet, to ensure that suppliers do not achieve higher ratings at the expense of other aspects of performance; and
- effects of the label on the market space (i.e. influence on consumer purchasing or product development).

Such mapping of existing policy instruments (voluntary or mandatory) enables us to identify the implementation related issues in terms of the methodology, scope, effectiveness, benefits and limitations of existing requirements, and finally to define the needs for a specific standard for water-using devices at the EU level (chapters 5 and 6).

Furthermore, the results of MS questionnaires provided additional information on instruments used at the national and sub-national levels, which complemented the collected information.

The following section gives an overall picture of the policy context in Europe and provides a background to current measures that indirectly affect WuPs. This background is followed by three sub-sections, divided by geographical scope: EU, specific MS and third countries. Mandatory and voluntary schemes that directly address the water performance of WuPs are listed and described under each sub-section. Finally, sub-section 4.6. pg. 182 gives an overall view of the different test standards and technical specifications that some of the mandatory and voluntary measures use to set water performance. This chapter will thus provide insights into the extent and location in which the different product groups are already covered by existing requirements, what methodology is employed for testing and evaluation, and what are their status and ambition levels.

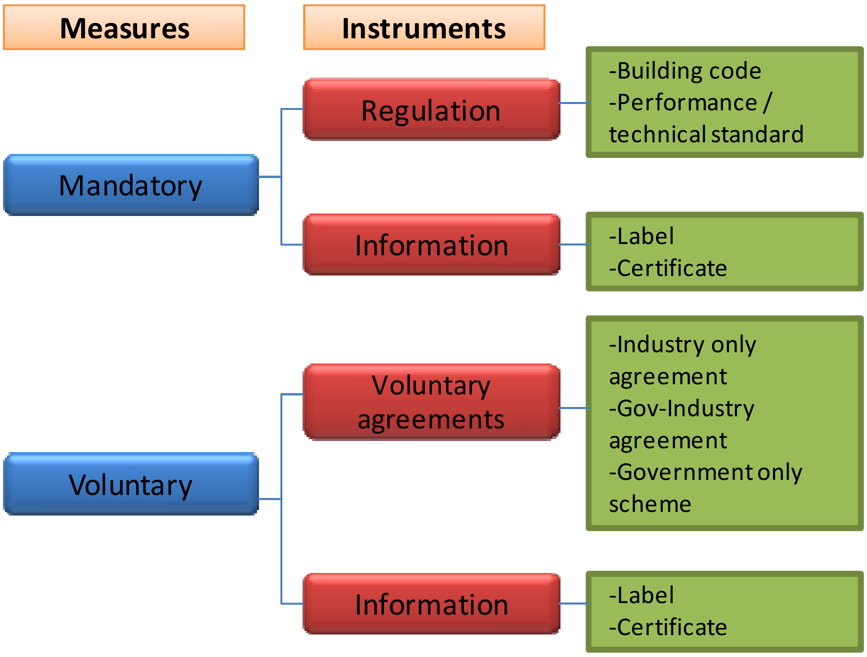
Appendices 1 and 2 of the report provide detailed factsheets for each of the identified mandatory and voluntary schemes identified across the EU and internationally.

4.2. EXISTING WATER EFFICIENCY POLICY MEASURES

To improve resource efficiency and promote sustainable consumption, governments are required to establish adequate policy frameworks. Local, regional and national governments can apply a wide range of different instruments for improving resource efficiency, including regulatory, economic, information, education, research, and development instruments as well as voluntary agreements and cross-sectional measures *(Vreuls 2005; GTZ et al., 2006)* (see Appendix 1). Each of these basic instrument groups covers a range of sub-categories which can be combined in order to enhance the desired effect. Different instruments are suitable for different objectives and address very specific "target audiences". Policies can range from "hard" strategies which reward or penalise consumers and producers to "soft" strategies which support and motivate the change of consumption or production patterns. The challenge for policy-makers is to select the appropriate instrument or mix of instruments to meet specific environmental objectives without compromising the functioning of the market or creating unfair economic or social impacts (*GTZ et al., 2006*).

In order to (1) encourage the purchase of higher efficiency products and (2) encourage the production and marketing of products that are more efficient than currently available, the majority of contemporary water efficiency efforts adopt regulatory, voluntary and informational instruments or combinations thereof. To facilitate the comparative assessment of the characteristics, benefits and limitations of different instruments at an aggregate level, relevant instrument sub-categories were identified and grouped according to their legal status (Figure 58).

Figure 58: Classification of policy measures developed for this study



Regulatory instruments refer to rules and regulations that require certain devices, practices, or systems design to improve water efficiency. They are established by public authorities and are subsequently enforced by compliance procedures. This group of policy instruments can include laws, Directives, and technical guidance documents as far as these are of a legally binding nature. The two main subcategories of regulation policy measures for water efficiency include minimum performance standards (MPS) and building codes.

Information instruments are designed to first increase the awareness of water efficient products, services, and benefits among a variety of actors. Secondly, information measures aim to persuade actors to adopt more water efficient practices and products. The two most commonly found instruments in this category are product markings which can be grouped into two sub-categories based on their methodology, namely rating or ranking labels, and endorsement certificates.

Voluntary agreements aim to encourage single firms, groups of companies or individual sectors to lower the water use or raise the water efficiency of their products, services or practices. Three sub-categories can be distinguished (*GTZ et al., 2006*): Unilateral agreements made by industry where one firm or a group of companies establish and commit to adhering to their own environmental goals, agreements between industry and public authorities refer to voluntary programmes jointly developed by public authorities and industry bodies, and finally voluntary agreement schemes set up by public authorities which invites individual firms to participate.

These defined categories will be further discussed and analyses under chapter 5.

4.3. POLICY MEASURES AT THE EU LEVEL

This sub-section lists the mandatory and voluntary instruments found at the EU level that regulate water performance requirements for certain WuPs.

4.3.1. MANDATORY MEASURES

- **Council Directive 92/75/EEC: labelling and standard product information of the consumption of energy and other resources by residential appliances**

This Directive stipulates the energy labelling requirements of residential washing machines and dishwashers. Under the Directive, washing machines shall use less than or equal to 12 litres of water per kg of wash load measured according to EN 60456:1999, using the same standard 60 °C cotton cycle as chosen for Directive 95/12/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines. For dishwashers, they shall be suitable for connection to a hot-fill water supply, and their water consumption (expressed as W(measured)) shall be lower or equal to the threshold as defined by the equation below using the same test method EN 50242 and programme cycle as chosen for Commission Directive 97/17/EC, which implements Directive 92/75/EEC with regard to energy labelling of household dishwashers:

$$W_{(measured)} \leq (0{,}625 \times S) + 9{,}25$$

where:

$W_{(measured)}$ = the measured water consumption of the dishwasher in litres per cycle, expressed to the first decimal,

S = the applicable number of standard place settings of the dishwasher.

- **Ecodesign Directive 2005/32/EC: establishing a framework for the setting of ecodesign requirements for energy-using products**

Currently, household washing machines and dishwashers fall under the Ecodesign Directive, although ecodesign requirements have not yet been set for household washing machines or dishwashers. However, working documents have been published on a possible Commission regulation implementing this Directive with regard to household washing machines and dishwashers (setting water requirements for washing machines and benchmarks for best-performing products for dishwashers) have been circulated (March 2009). In the case of washing machines, the proposed requirements are (*EC, 2009 1*):

- One year after this implementing measure has come into force, water consumption per cycle of standard 60°C cotton programme at full load shall be:
  $W_{t,60} \leq 5 \times c + 35$
  where c is the rated capacity at full load and Wt the water consumption.
  (i.e. 12 L/kg for 5kg load; 9,4 L/kg for 8kg load)

- Four years after this implementing measure has come into force, water consumption per cycle of standard 60°C cotton programme at full load shall be:

  Wt,60 ≤ 5 × ci + 35
  where ci is the rated capacity at half of rated capacity.
  (i.e. 19 L/kg for 2,5kg load in 5kg machine; 13,75 L/kg for 4kg in 8kg machine)

Benchmarks are also introduced:

- 35 L/cycle (5kg) or 7 l/kg
- 37 L/cycle (7kg) or 5,3 l/kg
- 52 L/cycle (8kg) or 6,5 l/kg

In the case of dishwashers, the benchmarks for best-performing products are provided (*EC, 2009 2*):

- For 6 place settings: 7 ll/cycle / cycle corresponding to 1.960 l/year
- For 9 and 12 place settings: 9 l/cycle / cycle corresponding to 2.520 l/year
- For 14 place settings: 10 l/cycle / cycle corresponding to 2.800 l/year

- Extension of the Ecodesign Directive to include energy-related products

At the end of March 2009, the European parliament and EU governments reached an agreement on proposals to extend the Ecodesign Directive to ***energy-related products***, including WuPs such as taps and showerheads *(ECEEE, 2009)*. The logic behind this is that less hot water spent by a shower or tap would also imply less energy needed to heat it, which would reduce total final energy consumption in the EU. Reducing water use would also lead to the reduction of environmental impacts of water supply. WuPs such as showers, taps, washing machines and dishwashers all offer households possibilities for water saving, equally diminishing the energy required to heat the water (*EC, 2008 b*).

4.3.2. VOLUNTARY MEASURES

- **European labelling of water-using appliances**

Council Regulation (EC) 880/92 of 23 March 1992 instituted an eco-label award scheme. On 16 July 2008 the European Commission presented a proposal for a regulation revising the EU Ecolabel scheme. The text of the new regulation was voted in the European Parliament on 2 April 2009 and we are now waiting for the Official agreement in Council. The new regulation would allow additional flexibility in reviewing the criteria if appropriate, strengthen the scheme by widening the number of products covered and make the system less costly and bureaucratic. The scheme was designed to promote products that have a reduced impact on the environment compared to otherwise similar ones and to provide consumers with accurate and scientifically based information and guidance.

The EU Eco-label has established water consumption criteria for different appliances including dishwashers (Decision of 28 August 2001 establishing the environmental criteria for the award of the Community Eco-label to dishwashers (2001/689/EC)) and of washing machines (Commission Decision of 17 December 1999 establishing the environmental criteria for the award of the Community Eco-label to washing machines (2000/45/EC)). Water performance standards under the EU Eco-label scheme for washing machines and dishwashers use the same requirements that are specified under the Council Directive 92/75/EEC that was just discussed in the section on mandatory measures at the EU level. It should be noted that Eco-label criteria for dishwashers and washing machines have expired since 30 November 2008 and 28 February 2009 respectively. Plans are underway in the near future to review the criteria to determine whether they will change and whether these products will stay under the Eco-label scheme.

In addition, the Eco-label scheme also applies water-saving criteria to campsite services and tourist accommodation services. For hotels and camping sites, the following criteria have to be fulfilled:

i) Water flow from tap or shower < 12 l/minute;

ii) No more than 5 urinals flushing at the same time;

iii) Water plants and garden after sunset or before high sun;

Choice of low environmental impact water source (when applicable).

4.4. POLICY MEASURES AT MEMBER STATE LEVEL

Several mandatory and voluntary policy instruments exist at the MS level to regulate the water performance of WuPs. This sub-section describes these measures and includes a summarising inventory table at the end, with minimum water performance levels for the corresponding WuP, scope, and standards for which the measures are based on.

4.4.1. MANDATORY MEASURES

4.4.1.1 Cyprus

Cyprus has adopted a law banning the use of hosepipes for the washing of cars or pavements and has established subsidies for water reuse.

4.4.1.2 Portugal

Water use and efficiency regulations appear to be limited in Portugal. However, the 1998 *General Regulation for Water and Drainage of Residual Waters in Public and Residential Building Systems (*RGAAR*)* (*Batista et al., 2001*) states that showers must have a minimum flow of 9 l/min in all buildings to prevent backflow.

4.4.1.3 United Kingdom

- **Water Supply (Water Fittings) Regulations**

In July 1999, the Water Supply (Water Fittings) Regulations 1999 replaced local water byelaws in England and Wales. They were made under section 74 of the Water Industry Act 1991 to prevent the waste, misuse, undue consumption, contamination or erroneous measurement of drinking water.

The Regulations set minimum standards for the water consumption of WCs, as well as washing machines, dishwashers and washer driers. They also contain requirements to ensure the durability and leak tightness of water fittings and guidance on minimising the length of pipe runs to reduce the run-off necessary to get hot or cold water from the tap[49].

- Toilets

In 2001, the Water Supply (Water Fittings) Regulations lowered the maximum flush volume of newly installed WCs from 7.5 litres to 6 litres and permitted the use of dual flushing mechanisms. WCs tend only to be replaced for aesthetic reasons (bathroom refurbishment), and this coupled with their long lifespan as a product mean that around 62% of existing housing in the United Kingdom has a high flush volume WC (flush volumes greater than 6 litres) (*Defra, 2008*).

In the United Kingdom, the only valve-less flush mechanism currently available is the siphon, which was a legal requirement under the Water Byelaws (superseded by the Water Supply (Water Fittings) Regulations 1999). Currently, most dual-flush WCs use drop-valve mechanisms, which allow the use of double buttons to activate the full and part flushes.

For siphons, the Water Fittings Regulations require any dual-flush device to default to full flush, the reverse of that which was applied to the dual-flush siphons of the 1980s in which the default was the half-flush. The current logic is that it is better to accidentally select the full flush and clear the bowl rather than accidentally selecting the part-volume flush which may not clear the bowl, thus requiring a repeat full flush.

Single-flush and dual-flush toilets are currently available that are more water efficient than the minimum required by the Water Supply (Water Fittings) Regulations. There are also a number of retrofit flushing devices available for reducing the flush volume of existing cisterns, but their effectiveness with older toilet bowls designed to be flushed with higher volumes of water has not been proved. It is essential that any proposed water-saving measures do not adversely affect the flushing performance of WCs, otherwise repeat flushing will take place and more water will be used.

[49] Water Supply (water fittings) Regulations 1999: WC Suite Performance Specifications

- Taps

The volume per use is affected by the expected in-use flow rate of internal taps installed under the following policies:

- Code for Sustainable Homes.
- Building Regulations.
- Water Supply (Water Fittings) Regulations.
- Water efficiency in existing buildings.

Initially, only the Code for Sustainable Homes will impact the flow rates of newly installed internal taps. Subsequently, the proposed changes to the Building Regulations will bring about a further reduction in the flow rates of internal taps installed in new properties. Changes are introduced more rapidly for basin taps than kitchen taps as fewer vessel filling activities are likely to occur in the bathroom environment.

From 2016 onwards it is likely that the impacts of changes to the Water Supply (Water Fittings) Regulations and any policy on water efficiency in existing buildings will begin to be seen, and therefore internal taps sold for replacement in existing properties will begin to increase in efficiency from this year onwards.

Washing machines: <27 l/kg wash load

- Washing machines, dishwashers and other appliances

In addition to taps and WC suites, the Water Supply Regulations also set requirements for domestic washing machines (including washer-driers) and dishwashers. So far regulations appear to extend only to domestic products of this type.

- Additional regulations

There are provisions for water companies to issue temporary hosepipe bans during early periods of drought. This currently prevents the use of hosepipes for garden watering and washing cars. If a drought persists, drought orders may be granted under a drought direction to further restrict specified domestic and non-domestic water uses and allow additional abstraction. These are granted to individual water companies within the area affected by the drought.

4.4.1.4 Spain

Although Spain does not appear to have national regulations for water efficiency, a number of municipal and regional regulations appear to exist. In 1998 the Government of Catalonia introduced a decree *(Decreto 202/1998)* which requires the installation of water saving devices in public service buildings. Moreover, the authority stipulates that all buildings newly constructed or renovated, both public and private, should include *(Fundacion Ecología y Desarrollo, 2009):*

- A recognised label that ensures water saving taps in the bathtub, shower, bidet, washbasin and sink.
- A mechanism for voluntary interruption of the output of water in toilets.

Other local and regional entities have taken the same course of action. For example, in 2006, the city council of Madrid introduced the *Ordenanza de Gestión y Uso Eficiente del Agua* which sets mandatory regulations for several residential and commercial WuPs. The ordinance aims to encourage the installation of water efficient products in the city and sets regulations for taps, showerheads, WCs, gardening and landscaping equipments and commercial car washes. Minimum performance levels are shown in Table 61. In addition to these measures, some are comparable between different cities and regions. Ordinances in Alcobendas, Asturias (Framework Order), Barberà del Vallès, Camargo, Castro Urdiales, Madrid, San Cristóbal de Segovia, and Sant Cugat del Vallès stipulate that taps installed in public buildings must use timers or any other similar self-closing mechanism that control water dosage per use, which limits water consumption to one litre (1 litre) of water per use.

4.4.1.5 Italy

As in Spain, there appears to be no specific national legislation which sets water consumption levels for WuPs throughout all areas of the country. However, certain areas carry their own legislation, which often differ greatly from one to the other. Within the *Building Regulations* of the City of Avigliana (*D.C.C, No. 91)*, it is stated that toilets in all new and renovated buildings must be equipped with dual flush systems with a maximum flush total of 6 litres. This rule does not apply for systems that rely on harvested rain-water, however. It is also required for all taps of the bathrooms and showers, except those of bath tubs, to reduce the flow of water to 8-12 l/min. Within the TS for the *General Regulatory Plan* of the municipality of Urbino (*D.C.C, No. 49*), newly installed toilets must use dual flush systems, where the larger flush may be between 5 and 8 litres and the smaller between 3 and 5 litres. In the province of Sassari on the island of Sardinia, *Energy Regulations* (*D.C.C No. 67*) also state that toilets in all new and renovated buildings must be equipped with a dual flush system, with a maximum total of 6 litres. As in Avigliana, this does not apply to systems dependent on the use of harvested rainwater. Furthermore, it is required that all taps of the bathrooms and showers, except those of bath tubs, reduce the flow of water to 8 l/min.

4.4.1.6 Ireland

In 2008 the Irish Minister for the Environment announced that the installation of dual flush toilets is now mandatory, both in new buildings and buildings where WCs are being replaced. This statement is confirmed by an amendment made in the Irish Building Regulations (amendment to Part G – Hygiene). Reduced flush requirements for WCs were also implemented by this regulation. These require installers to ensure that all new WCs are dual flush with a maximum flush not exceeding 6l/flush. The Regulations are enforced by the local authority Building Control sections.

The 2007 Water Services Act also provides for the introduction of measures to restrict water consumption during periods of drought or shortage of water. These measures could include – a hosepipe ban, ban on vehicle washing, etc.

4.4.1.7 Germany

Although mandatory measures in Germany do not appear to regulate the water consumption of WuPs directly, Paragraph 1 or Article 3 of the Federal Waste Water Regulations requires all installations which discharge waste water to use water saving procedures. In many industrial sectors water recycling is common.

4.4.1.8 Summary of existing mandatory measures

Although existing regulations in MS differ, some similarities can be observed. The most significant similarity perhaps is that the analysed MS have set efficiency requirements for toilets and these requirements are either the same or very similar (i.e. maximum 6L per flush). It is also worth noting that showers and taps are also given similar requirements between the two types of products and are the second most commonly regulated product. A great deal of water is consumed in households due to the use of sanitary products (especially toilets). It may be no surprise then that these products are more commonly regulated for. These are also often the most commonly bought WuPs for residential or commercial buildings, and may be easier to regulate or test when setting efficiency requirements. Table 61 summarises the water efficiency requirements for certain WuPs as specified in existing mandatory EU and MS schemes.

Table 61: Requirements of existing mandatory EU and MS water efficiency schemes

Name of Measure	MS/EU	Scope	Products covered and Water Performance requirements					
			Toilets	Washing machine	Dish washer	Shower heads	Taps	Car Wash
Council Directive 92/75/EEC: labelling	EU	EU level		<12 l/ kg	X			
Ecodesign Directive 2005/32/EC [50]	EU	EU level		5.3 – 7l /kg	7 – 10 l/ cycle[51]	X	X	
Ordenanza de Gestión y Uso Eficiente del Agua en la en la Ciudad de Madrid	Spain	Municipal (Madrid)	6 l/ flush			<10 l/min	<10 l/min	<70 l per vehicle
Ambientale al Regolamento Edilizio della	Italy	Municipal (Avigliana)	6 l/ flush			<12 l/min	<12 l/min	

[50] Please note that Ecodesign requirements for residential washing machines and dishwashers have not yet been voted into law, and that shower heads and taps would be included under an eventual extension of the Ecodesign directive for energy-related products.

[51] Depending on the number of place settings of the dishwasher: see section 4.3.1 for exact figures.

Name of Measure	MS/EU	Scope	Products covered and Water Performance requirements					
			Toilets	Washing machine	Dish washer	Shower heads	Taps	Car Wash
Città di Avigliana Variante all' Art. 8 delle Norme Tecniche di Attuazione del P.R.G	Italy	Municipal (Urbino)	<8 l/ flush					
Regolamento Energetico Ambientale	Italy	Provincial (Sassari)	6 l/flush			<8 l/min	<8 l/min	
Water Supply (Water Fittings) Regulations	United Kingdom	National	6 l/flush[52]	<27 l/kg[53]	<4.5 l/place setting			

4.4.2. VOLUNTARY MEASURES

4.4.2.1 Portugal

The National Plan for Efficient Water Use, introduced in 2001 by the Environment Ministry of Portugal, introduced a national strategy for reducing water consumption across the country (*Batista, et al., 2001*). The plan proposed an increase in efficiency from 58% to 80% in the urban setting, and 71% to 84% in the industrial sector within the space of 10 years. It sets out a series of actions which fall under the four following areas:

- Awareness, information and education (AP1);
- Documentation, training and technical support (AP2);
- Technical regulations and labelling standardization (AP3);
- Economic incentives, financial and tax (AP4).

In accordance with the proposals of the National Plan for Efficient Water Use, the National Association for Quality in Building Installations (ANQIP) launched a product certification system, along with a water efficiency labelling scheme (WELS), in Portugal (*Afonso, 2008*). The labelling scheme models itself on currently existing international schemes such as the Australian WELS label, and is based on a rating system, rather than an efficiency label. Under this scheme, the water efficiency of products has been rated from E (lowest) to A++ highest. The A+ and A++ ratings are meant for special

[52] For replacement installations where the existing WC remains, a 7.5 litre cistern can be fitted. In dual flush systems, 4L maximum allowed for the short flush.
[53] For domestic horizontal axis washing machines, <27L/kg of washload for a standard 60°C cotton cycle. For domestic washer-driers, <48L/kg kilogram of washload for a standard 60°C cotton cycle.

applications, as shall be illustrated later in the case of flushing cisterns. Following an audit and acceptance into the scheme, the product is awarded a label as show in Figure 59.

Figure 59: ANQIP Water Efficiency Rating Label

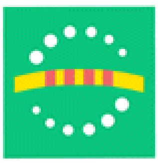
This voluntary scheme was launched in October of last year 2008 and, to date, has only introduced efficiency ratings for flushing cisterns. Cisterns were determined to be of highest priority as toilet flushing systems consume the greatest volume of water in Portuguese households. The labelling scheme was established in compliance with the draft European Standard for WC and urinal flushing cisterns (EN 14055:2007) (which will be described more in detail in sub-section 4.5, pg. 168). The award of A+ and A++ is reserved for the combined use of toilets suitable for low-volume flush, since not all toilets on sale in Portugal work properly with low-volume flush cisterns.

As well as toilets, ANQIP aims to introduce efficiency ratings for the showerheads, taps, washing machines and flow meters (commercial toilets and urinals) by the end of the 2nd quarter of 2009. Although mainly intended for the residential sector, the criteria may also be relevant for products in the commercial sector.

4.4.2.2 Spain

The Catalonian Environmental Quality Guarantee Label is a regional voluntary labelling scheme introduced in Catalonia in 1994 (2004 for water-saving products and systems covered from 2004). The scheme is managed by the Environmental authority of the Generalitat de Catalunya and was introduced to define products and water conserving systems of high environmental quality, to help consumers easily identify water efficient products. Although, like the EU label, the Catalonian Environmental Quality Guarantee Label sets standards for an array of products, and for some, focuses on a number of criteria (such as energy consumption). For WuPs however, the label does set out specific efficiency levels which are detailed in Appendix 2. The label does not set out a rating system, but instead indicates which products are the most water efficient according to the listed criteria. See Figure 60 for an image of the label.

Figure 60: The Catalonian Environmental Quality Guarantee label



At present, the scheme can only be joined by manufacturers with plants in Catalonia and distributors of own-brand products marketed in Catalonia. Despite the small geographical scope, the label sets efficiency levels for many sanitary products including shower elements (fixed and mobile showerheads), taps (lavatory, bidet and sink faucets, and flow limiters), WCs and water saving devices for WCs and applies to both the residential and commercial sectors.

4.4.2.3 United Kingdom

➢ **Waterwise Marque**

The Marque is awarded annually to products which reduce water wastage or raise the awareness of water efficiency. Figure 61 shows an example of the Waterwise label.

Figure 61: Waterwise Marque logo

27 marques have been awarded across a broad spectrum of products including dishwashers, showerheads, water storing gels for the garden, toilets and urinals, drought resistant turf, domestic water recycling products, water butts, a waterless carwash, tap flow restrictors, a shower timer and devices to reduce the amount of water used when flushing the toilet (*Waterwise (5), 2009*).

➢ **BMA Scheme**

The Bathroom Manufacturers Association (BMA) is the lead trade association for manufacturers of bathroom products in the United Kingdom and has launched a Water Efficient Product Labelling Scheme (*Bathroom Manufacturer's Association, 2008*). Figure 62 shows an example of the label.

Figure 62: BMA Water Efficient Product Scheme label

Outlined below are the Scheme's criteria that products must meet to qualify for the water efficient product label.

The scheme is designed to raise awareness of bathroom products that, when installed and used correctly, use less water and therefore save both water and energy, whilst not lowering the standard of the bathing experience.

This Water Efficient Product Labelling Scheme is open to all companies who manufacture or sell bathroom products within the United Kingdom that meet the criteria for water efficient products as defined by technical experts within the United Kingdom Bathroom Industry. Over 300 products have since received the BMA Label.

4.4.2.4 Ireland

The City of Dublin Energy Management Agency (CODEMA) in collaboration with the Dublin Region Water Conservation Project (DRWCP) developed the Water Conservation Label to promote conservation and to provide consumers with information on water efficiency. The goals of the programme were to conserve water, save energy and costs, and ensure quantity and quality of water supply.

The label was developed in conjunction with the Dublin City Council Water Bye-laws that require "[...] clothes washing machines, washing machine-driers and dishwashers […] to be economical in the use of water".

Around 2003, CODEMA developed and printed water efficiency labels and then distributed them to retailers in the Dublin Region as a pilot project. Washing machines and dishwashers were the only products covered.

The label provided an efficiency rating of 1 to 7, with 1 being the most efficient. Ratings were based on consumption. CODEMA is no longer producing these labels and the programme seems to have entirely dissolved.

4.4.2.5 Germany

The Blue Angel national labelling scheme is designed to distinguish the positive environmental features of products and services on a voluntary basis. Created in 1978, it is one of the most well-known eco-labels worldwide. It is not specially focused on water aspects but deals with the overall environmental impact of a wide range of products.

Toilets (flushing boxes) and waste-water free car wash facilities are covered by this label.

In order to be certified, flushing boxes must be fitted with devices reducing the flushing-water volume or interrupting the flushing, in accordance with the TS DIN 19542. The flushing-water volume must be in a given range and the fixtures must bear explicit indications on how to use it properly (German Federal Environment Agency, 1985).

4.4.2.6 Sweden

Section 6 on hygiene, health and the environment of the Swedish Building Regulations makes recommendations for water flow from taps in households (B.B.R. No. 22). The regulations also differentiate between tap types, including cold water, and hot and cold water taps, as well as taps for bathtubs and other outlets. The document focuses specifically on ensuring that such installations are designed in such a way that tap water is hygienic and safe for end-users. Therefore, flow rates may be a reflection of this rather than a restriction in the interest of saving water.

4.4.2.7 Nordic eco-label

The Nordic eco-label, commonly known in the Nordic countries as "the Swan" because of its symbol, is the official eco-label scheme in place in the Nordic countries (Denmark, Finland, Sweden, Norway, and Iceland). Like the Blue Angel, it addresses general environmental, quality and health criteria for a wide range of products.

The Nordic eco-label deals with washing machines, dishwashers, car wash facilities, hotels, restaurants, and laundries.

Dishwasher water consumption has to be measured in accordance with British TS BS:EN 50242. The label also sets a minimum performance level of water consumption for washing machines but doesn't refer to TS[54]. For hotels and restaurants there are some requirements addressing water efficiency like such as metering and water saving taps and toilets.

4.4.2.8 Summary of existing voluntary measures

As with MS regulations, WCs once again receive the most focus. However, some voluntary schemes focus on a greater number of products such as the Nordic eco-label. The maximum water consumption levels for toilets vary greatly, from as low as 4.5L to twice the volume at 9L per flush. The requirements for different products seem to differ much more than those set in mandatory regulations. The requirements for taps and showers appear to be different within each scheme; consumption is often set lower for taps, whereas mandatory regulations do not differentiate between either. The majority of these schemes are also more far-reaching than current MS regulations which may set requirements for a very exclusive area (such as a city or municipality). Table 62 summarises the water efficiency requirements of existing voluntary EU and MS schemes.

[54] Swan-labelling of Washing machines. Version 4.1 and Swan-labelling of Dish washers, Version 3.1

Table 62: Summary of the requirements of existing voluntary EU and MS water efficiency schemes

Name of measure	MS/ EU	Related Standards	Scope	Products covered and Water Performance requirements					
				Toilets	Washing machine	Dish washer	Shower heads	Taps	Car Wash
The EU Eco-label[55]	EU	*EN 60456:1999 and EN 50242*	EU level		<12 l/kg of wash load	X			
Certificação da Eficiência Hídrica de Produtos	Portugal	*PrEN 14055*	National	4.0 – 9.0 l/flush [56]	x	x	x	x	
Distintivo de Garantía de Calidad Ambiental Catalán	Spain	*UNE 67-001-88 EN 246:2004*	Regional (Catalonya)	<6 l/min			<12 l/min	<9 l/min	
BMA Water Efficiency Labelling Scheme	United Kingdom	*EN 997:2003 and PrEN 14055:2007*	National	<4.5 l/flush			<13 l/min	<6 l/min	
The Blue Angel	Germany		National	6 – 9 l/flush					Waste-water free system
The Nordic eco-label	Scandinavia	*EN 50242:2008*	Transnational	< 6 l/flush dual flush option[57]	16 l/kg of wash load	1.2 l/ place setting		Maximum 8-10 l/min[58]	< 70-90 l/car
Building Regulations (Section 6)	Sweden		National					<18 l/min	

[55] Please note that water performance requirements for washing machines and dishwashers are no longer valid since expiration of criteria from 30 November 2008 and 28 February 2009 respectively. Plans are underway in the near future to review the criteria to determine whether they will change and whether these products will stay under the ecolabel scheme.
[56] For dual flush systems, 3.0 l. maximum for the short flush
[57] Nordic Eco-label indirectly addresses those products via criteria for hotel and restaurant
[58] ibid

4.4.3. OTHER INITIATIVES IN MEMBER STATES

4.4.3.1 United Kingdom

The Enhanced Capital Allowances (ECAs) scheme in the United Kingdom applies to business and industry. The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital purchase of certain types of environmentally efficient equipment. The types of qualifying equipment fall under the following broad categories:

- Energy-saving plant and machinery,
- Low carbon dioxide emission cars and natural gas and hydrogen re-fuelling infrastructure, and
- Water conservation plant and machinery.

Unlike most of the European schemes here listed, which focus largely on residential and commercial WuPs, the ECAs scheme, which is run by Defra, covers a wide range of commercial and industrial WuPs. With regard to sanitary WuPs (i.e. cisterns, taps, showerheads, etc) the document refers to the levels already set in the 1999 Water Fittings Regulations. Other products such as industrial and commercial cleaning equipment have efficiency ratings set by the authority.

4.4.3.2 Estonia

Water abstraction and water use is controlled in Estonia according to national water prices. In terms of water abstraction, the Estonian Water Act states in particular that water abstraction is a special use of water. In order to abstract more than 5 m^3 of groundwater or more than 30 m^3 of surface water per day, interested parties must apply for a permit from the Environmental Board`s local region office. Water use is also distributed at a fee. This applies to all domains, including water use in residential, commercial and industrial water use. Water efficiency is therefore influenced and promoted by the price of water. Although this national policy does not have direct control over product consumption, it has appeared to result in a decreasing trend in water consumption.

4.4.3.3 Germany

Germany has a long tradition of water management. The Federal Water Act (Art. 1a para.2) obliges everyone to prevent detrimental changes of water properties in order to achieve an economical use of water. This general rule is supported by special rules concerning the management of water quality (e.g. by implementing the combined approach of BATs for emissions and Environmental Quality Standards for the receiving water bodies; designation of water protection areas covering 12% of Germany´s total area) and quantity (especially for groundwater).

Water metering is also employed in most households and industries to allow pricing according to water use. The price of water has an influence on consumer and industrial water consumption, encouraging them to reduce water consumption in order to reduce the cost of their water bill. In the case of public water use, the costs of abstraction are passed on via their water bill. The German government has therefore observed a decreasing trend of water consumption in households since the 1970s.

Similar to Estonia, many Federal States require those who abstract water to pay a fee. This can, in some cases, apply to groundwater or surface water, depending on the state. The purpose of the water extraction charge is to minimise water extraction to a sustainable degree and thereby conserve water resources. The water extraction charges collected are often reused for water conservation measures.

4.4.3.4 Ireland

The Department of the Environment provides some funding for water conservation work by Water Service Authorities. This work is generally directed at the public water supply (supplier side) and not at the consumer side.

A national training programme for water conservation and leakage detection/location is also forecast to be launched in May 2009 (this programme will build on work already under way). While there is no specific national programme, there appear to be initiatives at regional level to raise public awareness regarding water conservation.

4.5. POLICY MEASURES IN THIRD COUNTRIES

It is important to also include existing policy measures outside Europe that regulate or promote the improved water performance of WuPs. Certain schemes could provide valuable guidance and imply the feasibility of such programs in Europe. The following sub-section gives a brief description of the most important mandatory and voluntary schemes that exist outside Europe. Appendix 3 includes more detailed information on these schemes (minimum performance levels, requirements, testing methods, etc.).

4.5.1. MANDATORY MEASURES

4.5.1.1 Australia

- **Australian WELS**

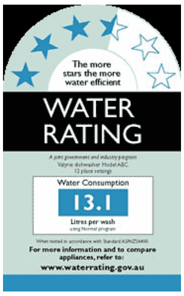
The purpose of the *Water Efficiency Labelling and Standards Act 2005* (the WELS Act) is to provide for the establishment and operation of a scheme to apply national water efficiency labelling and MPS to certain WuPs. In November 2006, the Environmental Protection and Heritage Council agreed to a long-term programme of work on the introduction of MPS for existing WELS products. The objectives of the scheme, as laid out in the *Water Efficiency Labelling and Standards Act 2005*, are threefold: 1) To conserve water supplies by reducing water consumption; 2) to provide information for purchasers of water-using and water-saving products; and, 3) to promote the adoption of efficient and effective water-using and water-saving technologies.

The Australian WELS Scheme replaces the voluntary National Water Conservation Rating and Labelling Scheme (the 'AAAAA' Scheme).which was introduced in 1988 with two efficiency grades, A and AA. A third tier, AAA, was introduced in 1992, and AAAA and AAAAA followed in 2001. AAAAA indicates the most water efficient product. The 5A scheme originally covered showerheads and dishwashers, but later expanded to include washing machines, urinal operating mechanisms, taps and tap outlets, toilet suites and matching-set cisterns, and flow regulators.

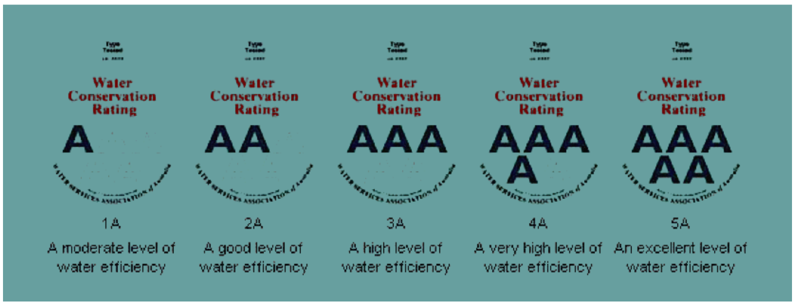
The design of the WELS label goes beyond that of the 5A Label. While the WELS label follows the 5A Label in that there are five efficiency ratings, the WELS label also includes a sixth category of ‘0 Stars’ that indicates that the product is not water efficient or that it does not comply with applicable standards. The label carries two important pieces of information to help the consumer compare products - stars and water consumption or water flow figures. For better water efficiency - the more stars the better and the lower the number the better. Figure 63 shows these two labels. The label shows:

- one to six star rating for a quick assessment of the model's water efficiency - the more stars on the label the more water efficient the product and
- water consumption per use (white goods, sanitary ware) or the water flow per minute (plumbing products) based on laboratory tests.

Figure 63: WELS label and previous 5A Scheme rating system



WELS label



5A Scheme rating system

Product groups that carry this water rating label include:

- Washing machines
- Dish Washers
- Lavatory Equipment
- Showers
- Tap Equipment
- Urinal Equipment
- Flow Controllers

The WELS is now mandatory for all showers, toilets, domestic washing machines, domestic dishwashers, urinals[59], and all taps used at basins, laundry troughs, and

[59] Waterless urinals are not currently included under the WELS Scheme

kitchen sinks. The scheme continues to be voluntary for flow control devices. The Australian Department of Environment and Heritage is currently considering an expansion of the WELS to include new products such as washer-driers, evaporative air conditioners, instantaneous gas hot water systems, hot water re-circulators, and domestic irrigation flow controllers.

All domestic and imported products covered by WELS are legally required to be labelled. Manufacturers must complete an online application and pay a registration fee of AU$1,500. Successfully labelled products remain registered for five years unless the registration is cancelled or suspended under Section 31 of the Act. WELS inspectors undertake both random and targeted inspections. WELS inspectors have numerous powers under the WELS Act, including searching WELS premises, taking photographs and securing evidential material.

Successfully registered products appear in the Commonwealth of Australia Gazette Government Notices, and details of the registered product appear on the Registered Products Database on the official WELS. The database is searchable by capacity, brand, and other variables and includes a water consumption calculator that allows the user to input information that alters one of the other database columns. Since the WELS came into effect, over 8,000 registrations have been made.

4.5.1.2 New Zealand

- **New Zealand WELS**

The New Zealand WELS regulations will come into force in July 2009. The Ministry of Consumer Affairs (MCA) has responsibility for the regulations, and the Ministry for the Environment is in charge of their implementation. The Commerce Commission will enforce the scheme. Regulations are being finalised with the Government now. They will require all new products to be tested and labelled by 1 July 2010. There will be a special provision for any items that were already in stock in July 2009 to be cleared without being tested and labelled. As with the Australian WELS, the New Zealand WELS will also rely on AS/NZS 6400 for much of the same detail, but will not necessarily include all requirements of the standard because some of these relate only to compliance in Australia. There will therefore be amendments to the joint standards AS/NZS 3718 and AS/NZS 3662, relating to testing of taps and showers. The existing versions of the standards only cater for mains pressure plumbing, which is predominant in Australia but not in New Zealand. Other major differences between the New Zealand and Australian WELS include the following:

- Additional requirements for taps and showers: low pressure hot water systems are most common in New Zealand, in contrast to high pressure systems in Australia, thus star ratings for taps and showers in New Zealand will also feature information on efficiency at low and at high pressures. The Ministry of Consumer Affairs is seeking to introduce an independent New Zealand standard or to amend AS/NZS 3718 and AS/NZS 3662:2005 to allow for alternative testing procedures;

* Mandatory registration not required: New Zealand will not require the registration of WuPs as is the case in Australia. Instead, New Zealand is encouraging industry to establish their own voluntary registration scheme in order to provide additional guarantee to customers;
* Minimum standards for toilets and urinals will not be set.

4.5.1.3 United States

➢ US National standards under the Energy Policy Act

In the United States, there are national efficiency standards and specifications for residential and commercial water-using fixtures and appliances. These stem from the Energy Policy Act of 1992 (EPAct 1992), which amended the National Energy Conservation Policy Act (NECPA) and established several energy management goals. The EPAct 1992 amended NECPA by adding water conservation and the use of renewable energy to the energy efficiency requirements. The introduced requirements are included in the summary table (Table 63 :Minimum water performance level and products covered by mandatory measures at the international level Table 63) at the end of this sub-section and in the factsheets found in Appendix 3. Product groups that fall under these standards include:

* Toilets (commercial and residential)
* Taps (residential and commercial)
* Showerheads
* Washing machines (commercial and residential)
* Ice Makers
* Urinals
* Dishwashers (residential)
* Pre-rinse Spray Valves

4.5.1.4 Singapore

➢ Singapore WELS

Starting from 1 July 2009, the Singapore WELS will be mandatory for the following products.

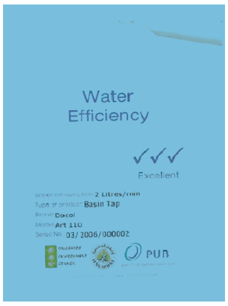
* Shower Taps and Mixers
* Taps and Mixers (Basins and Sinks)
* Dual Flush Low Capacity Flushing Cisterns (Dual Flush LCFC)
* Urinal Flush Valves
* Waterless Urinals

Washing machines and showerheads are covered in the voluntary Singapore WELS. The scheme does not cover dishwashers, outdoor products like hoses, or grey water and rainwater systems.

The Singapore WELS was introduced on 31 October 2006 to help consumers make informed choices and to encourage manufacturers to develop more efficient products. The label features a simple grading system of one to three ticks, with three ticks being the best, and displays water consumption figures and other general product information. See Figure 64 for an image of the label. It may appear on display units either in the form of an adhesive label or as a tag. The label may also be affixed on packaging prior to sale. All WELS labelled products are also listed on the WELS website.

At launch in October 2006, fifteen brands were already participating in the labelling programme. As of end December 2007, 561 products have received the label, representing 52 brands. Figure 64 shows an example of the label.

Figure 64: Singapore WELS label



To qualify for a label the product must meet the Public Utilities Board (PUB) performance requirements for water efficiency and must comply with standards. The Singapore WELS is based on Singapore standards (SS) and AS/NZS 3662:2005 depending on the product covered. See Table 63, pg. 173 and sub-section 4.6, pg. 182 for further details on test standards and water performance requirements.

4.5.1.5 Summary of mandatory measures at the international level

This sub-section summarises the mandatory measures and standards that regulate WuPs. The Singapore WELS is included in a separate table as it has more specific water performance requirements as is determined by the rating system.

Some preliminary observations can already be seen based on the inventory table (Table 63) and information collected on existing mandatory regulations outside of Europe. Firstly, at the international level, WELS seems to be quite prevalent in the Asia Pacific region. Under WELS, national standards are used or in the case of Australia, a new set of standards was specifically established for the WELS. In addition, under WELS, countries have chosen either to use it as an endorsement mark (New Zealand and Singapore) or as a rating system (Singapore). Minimum water performance levels vary greatly depending on the measure and product. All of the mandatory schemes discussed in this sub-section have been implemented relatively recently – from 2005 onwards. In the case of the Singapore WELS, the Scheme does not officially begin until July 2009. Most of these mandatory schemes address the range of WuPs found in the residential and commercial sectors. Finally, all four measures address showerheads and taps and under the USA Energy Policy Act, water performance standards are set for all WuPs listed in Table 63.

Table 63 :Minimum water performance level and products covered by mandatory measures at the international level

Name of Measure	Standard	Products covered and Water Performance requirements[60]					
		Toilets	Washing machine	Dish washer	Shower heads	Taps	Urinals
Australia WELS	AS/NZS 6400:2005 and other national product standards	≤ 5.5 l/flush	X	X	6 to 7 l/min	≤ 2 l/min	1.5 l/flush
New Zealand WELS	AS/NZS 6400:2005 and other national product standards		X	X	6 to 7 l/min	≤ 2 l/min	
USA Energy Policy Act	EPAct 1992, 2005	6.0 l/flush [61]	WF ≤ 9.5 gal/cycle/ft3[62]	WF ≤ 4.5 to 6.5 gal/cycle[63]	9.5 l/min	8.3 l/min [64]	3.8 l/flush
Singapore WELS[65]	SS and AS/NZS 3662:2005	> 2.5 to 4.5 l/flush	9 to 15 litres/kg[66]		5 to 9 l/min [67]	2 to 9 l/min	0.5 to 1.5 l/flush

[60] An « X » implies that the product is covered under the scheme but does not have specific minimum water performance levels. Detailed information on pressure specifications for taps and shower-heads are included in the fact sheets

[61] Refers to both commercial and residential toilets

[62] **Water Factor, WF**, for a washing machine it is the quotient of the total weighted per-cycle water consumption, Q, divided by the capacity of the washing machine, C. The lower the value, the more water efficient the washing machine is. The equation is shown here: WF=Q/C

[63] Also includes pre-rinse spray valves - Flow ≤ 1.6 gal/min (pressure not specified)

[64] EPAct 1992 standard for faucets applies to both commercial and residential models.

[65] Please note that water performance requirements for the Singapore WELS are based on their rating system (good, very good, and excellent). In this table, ranges are used. For more specific water performance requirements for each product please consult the Singapore WELS fact sheet in Annex 1.

[66] Labelling of washing machines is voluntary under the Singapore WELS Scheme

[67] Labelling of shower-heads is voluntary under the Singapore WELS Scheme

4.5.2. VOLUNTARY MEASURES

4.5.2.1 Australia

➢ **SmartApproved Watermark**

The Smart Approved WaterMark is a nationally endorsed voluntary label that was introduced in 2004 (*Smart Approved WaterMark, 2009*). Smart Approved WaterMark is Australia's labelling scheme for products and services that are helping to reduce water use outdoors and around homes. Therefore, while the WELS label assists in the conservation of indoor water use, the objective of the WaterMark is to assist in the reduction of outdoor consumption. The WaterMark was re-launched in 2006 after government funding allowed the brand to be marketed more prominently as previously the label had little exposure. Figure 65 shows what the label looks like.

Figure 65: *SmartApproved Watermark*

The WaterMark is operated as a not-for-profit, voluntary scheme hosted at WSAA. An independent Technical Expert Panel assesses applications on four criteria:

1. The primary purpose of the product/service is to reduce actual water use and/or enable the use of water more efficiently;
2. The appropriate use of the product/service is consistent with supplied instructions and other documentation;
3. The product/service is of high quality and meets industry standards, and the water reduction does not result in the compromise of quality or performance; and,
4. The product/service is environmentally sustainable and will not adversely affect the environment in other areas (e.g. cause water pollution).

While the current label takes the form of a simple endorsement mark, discussions are underway over whether the label should be expanded into a rating label similar to the WELS label. Guidelines for specific product ranges, including testing methodologies and minimum standards of water savings (e.g. pool covers must show a minimum of 40% water savings), are currently being developed. The aim is to expand the range of guidelines as the number of comparable product groups increases. Applicants who have already received the label will have to meet new guidelines upon renewal, as label licensing is valid for only two years. Over 130 products and services are currently labelled with the WaterMark. Products and services that fall under this initiative are shown in Table 64.

Table 64: Products and Services covered by the SmartApproved WaterMark

Products	Services
• drip systems; • watering spikes; • low flow hoses; • high pressure cleaning devices; • micro spray systems; • grey water permanent tank systems; • electronic water controllers; • moisture/rainfall sensors; • temporary grey water diverters; and, • mulches and wetting agents; • rainwater tanks; • low flow car washes.	• water efficient plumbers; • plant labelling schemes; • water saving retrofit services • IAA Certified Irrigation Designer services for water efficient gardens and irrigation systems; and, • water saving training and accreditation programmes; • water efficient designs of occupied and new buildings; • IAA Certified Landscape Irrigation Auditor programmes. • maintenance programmes for irrigation systems;

Applications are open to companies that manufacture and/or distribute water saving product(s) or deliver water saving service(s) in Australia. Approved companies can use the WaterMark for a period of two years from the date of issue, after which the company must reapply.

➢ **Car Wash Rating Scheme (Australia)**

The Car Wash Rating Scheme is aimed at reducing the volume of potable (drinkable) water used at commercial car washes by promoting efficient water use and practices. It is run by the Australian Car Wash Association for commercial car wash operators. The Car Wash Water Saver Rating Scheme enables responsible car wash operators to demonstrate their high environmental standards in both water use and the disposal of waste water to sewer. It provides a unified branded benchmark, which has been developed to help secure the future of commercial car washes even in times of severe water shortages. While being a national standard, it is also flexible enough for compliance with local water restrictions.

The Scheme is for all members of the vehicle washing industry and is administered by the Australian Car Wash Association on a non-profit basis. The WRS has just received accreditation from the federal Smart Approved WaterMark (see previous sub-section).

The Car Wash Water Rating Scheme measures the amount of mains potable (drinking) water used by car wash equipment in a defined standard wash, and then rates that equipment on its water efficiency. If one site has two or more types of equipment, they are rated separately and the rating signs must be displayed so as to clearly identify which rating applies to each type of equipment.

The rating Scheme uses the well-understood star rating system – five stars being the best result, which indicates the lowest amount of potable water used per wash. Once a car wash has been successfully audited, it will receive rating signage and a public information poster to display, plus additional promotional materials. Figure 66 shows what the car wash rating scheme label looks like.

Figure 66: Car Wash Rating Scheme Label

4.5.2.2 United States

- **WaterSense**

In the US, the Environmental Protection Agency (EPA) introduced in 2006 the WaterSense label. WaterSense is a national public-private partnership that brings together government, manufacturers, retailers, water companies, consumers and other stakeholders to promote the efficient use of water. Like EPA's successful Energy Star program for energy-efficient devices, WaterSense seeks to educate consumers through an easily identifiable label (*United States Environmental Protection Agency, 2009).* The programme includes a WaterSense label for water efficient products and a certification programme for services (e.g. irrigation professionals). It was decided that the label take the form of an endorsement or mark of approval rather than a ranking such as the Australian WELS because programme developers felt that a voluntary mark would better transform the market without alienating manufacturers, who disliked the idea of a ranking label. Furthermore, a ranking label would have been significantly harder to manage and much more expensive to operate. Figure 67 shows an example of the WaterSense label.

Figure 67: WaterSense programme label

Generally speaking, WaterSense labelled products are 20% more water-efficient than conventional models on the market, and provide equal or superior performance. The label is available for taps, showerheads, toilets, and urinals.

Dishwashers and clothes washing machines are not and will not be covered under WaterSense. These products are covered under the USA EnergyStar programme (see below), which now includes water as part of its award criteria for dishwashers and washing machines. The WaterSense label was established with the understanding that all EuPs, even those that use water, will fall under the purview of EnergyStar, while only those products that do not directly use energy will fall under WaterSense. Showers were considered to fall under WaterSense. The Water sense requirements are presented in the summary table at the end of this sub-section (Table 66, pg. 180).

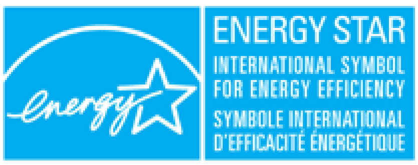
There are no fees associated with partnership, labelling, or listing of a product as part of the WaterSense programme; however, all fees associated with third party testing must be met by the manufacturer. Every WaterSense labelled product has to be certified by a third party to meet all criteria set out in relevant EPA WaterSense specifications and in national standards. WaterSense specifications are developed by the EPA through market research, technical review, and stakeholder consultation. Specifications are reviewed when necessary as the market advances. The label does not list actual consumption of the labelled products because it was felt that such information was too much for consumers who simply wanted a yes or no answer as to whether or not a product was water efficient.

While the programme is limited to the USA, the label may also appear in Canada since the market crosses borders and since the two nations share plumbing health and safety standards. The WaterSense programme is funded through the EPA's core budget, from which about US$2 300 000 is allotted annually for the programme. The programme is overseen by six permanent, fulltime staff members within the EPA.

- **ENERGY STAR®**

The Energy Star Programme is a voluntary labelling scheme which aims to improve the energy efficiency of different products and equipment. It does also introduce, for certain products, water efficiency requirements. An important difference with the WaterSense programme is that whereas WaterSense includes a performance requirement and third party testing, EnergyStar does not – the label is based on manufacturer declarations. Figure 68 shows what the energy star label looks like.

Figure 68: Energy Star label



The different water performance requirements for different WuPs are specified under the US EPAct national standards.

Products manufactured before January 1, 2007 that qualified for the previous criteria, and do not qualify under the current criteria, may still be labelled with the ENERGY STAR logo and retailers may continue to promote these products as qualified until March 31, 2007 (*ENERGY STAR, 2007*).

4.5.2.3 Hong Kong

- **Hong Kong Water Efficiency Labelling System**

The voluntary Hong Kong WELS is a water conservation initiative that the Government of the Hong Kong Special Administrative Region adopted in 2009. The adoption of WELS in Hong Kong aims to provide consumers with information on the levels of water consumption and efficiency ratings of plumbing fixtures and water-consuming appliances and thus to achieve actual water saving. The Scheme has just recently been implemented, thus currently the Scheme covers only showers for bathing. It is based on the Australian/New Zealand standard *AS/NZS 3662:2005 - Performance of showers for bathing*. The Hong Kong WELS will be implemented in phases for different groups of plumbing fixtures and water-consuming appliances. Showers are the first phase product.

4.5.2.4 Singapore, South Korea, Thailand, Japan eco-Labels

Singapore, South Korea and Thailand participate in voluntary eco-label (or green label) schemes that cover specific WuPs. Japan has a similar label called the EcoMark. All of these countries are members of an international association of eco-labelling program operating agencies, the Global Eco-labelling Network (GEN). Oftentimes the green labels cover just a few WuPs. Eco-labelling (or green-labelling) refers to a scheme which awards environment-friendly products with eco-labels. It is a voluntary method of environmental performance certification and labelling that is practised around the world. An eco-label is awarded by an impartial third-party in relation to certain products or services that are independently determined to meet environmental leadership criteria. ISO (International Organisation for Standardisation) 14024[(1)] Type I label, which involves a third-party certification requiring considerations of life cycle impacts. Some of the key criteria contained in these standards also require compliance with applicable legislation.

The Singapore Green Labelling Scheme was launched in May 1992 by the Ministry of the Environment. The only WuPs currently covered by this scheme are washing machines. The green label can be used on products which meet the standards specified by the scheme and are recognised as a member of the international Global Ecolabelling Network (GEN) allowing certification by mutual recognition of nationally endorsed products by other international members of the network. Both local and foreign companies can participate in the scheme.

The Korea eco-label Program has been in operation since April 1992, certifying Eco Labels to qualifying eco-products for excellent quality and performance, as well as general environment-friendliness during the entire production process. The Korean eco-label program is a certification program executed by the Ministry of Environment. The designated eco-label includes a brief description, in order to reduce consumption of energy and resources and to minimise the generation of polluting substances in each production step. The program is run by Korea's

Ministry of Environment. Products covered under this scheme include water-saving toilets, taps, and showerheads. Products are tested according to specific test methods and standards. Figure 69 and Figure 70 show the certification criteria (environmental and quality) that products must fulfil to obtain the Korea eco-label.

The Thailand Green Labelling Scheme was initiated by the Thailand Business Council for Sustainable Development (TBCSD) in October 1993 as a TBCSD council project. It was formally launched in August 1994 by the Thailand Environment Institute (TEI) in association with the Ministry of Industry. The symbol on the Thai Green Label signifies environmental conservation. The flora (the leaves) and fauna (the bird) depicted are the living wonders of the world. Products covered under this scheme include taps, showers, flush valves for urinals, flushing toilets, washing machines, and commercial laundry machines.

The Japan EcoMark Program was created in 1989 and serves to suggest wise product choices for an ecological lifestyle and, ultimately, an environmentally sound society. Like the eco-labels that have just been discussed, the Eco Mark program is managed in accordance with the standard principle ISO 14020 - An environmental label and declaration, a general principle, and ISO 14024 - An environmental label and declaration, a type I environmental-label display. The program is run by the Japan Environment Association. The Eco Mark Committee for establishing product categories and criteria consists of representatives from industry, consumers, and academia. Products covered under this scheme include taps, showers, flush valves for urinals, flushing toilets, washing machines, and commercial laundry machines water-saving equipment toilets and taps. Table 65 shows the corresponding green labels and country that cover certain WuPs.

Table 65: Eco-labels that cover WuPs

Singapore Green Label	
Korea eco-Label	
Thai Green Label	
Japan EcoMark	

4.5.2.5 Summary of voluntary measures at the International level

Table 66 summarises the various voluntary measures on setting water efficiency standards that exist outside of Europe.

Some preliminary observations can already be seen based on the above inventory table and information collected on existing voluntary schemes and initiatives outside of Europe. Firstly, most of these voluntary initiatives apply only at the national level except in the case of the Singapore Green Label which extends its program to other countries. In most cases, the voluntary schemes use test standards or technical specifications to set criteria for the WuPs. Certain schemes address very specific WuPs such as the Car Wash Rating Scheme (Australia), which covers only commercial car washes, the SmartApproved Water Mark (Australia) which covers only outdoor WuPs, and the Singapore green labels which covers only residential washing machines.

Table 66: Inventory table of international voluntary Initiatives

Name of Measure	Standards used	Outdoor products covered and Water Performance requirements					
		Hoses	Spray/ Drip systems	Grey/rain water tank	Water Controllers	Rainfall sensors	Car Wash
SmartApproved Water Mark (Australia)	N/A[68]	X	X	X	X	X	X
Car Wash Rating Scheme (AU)	N/A						X
		Indoor WuPs covered and Water Performance requirements					
Name of Measure	Standards used	Toilets	Washing machine	Dish washer	Shower heads	Taps	Urinals
Singapore WELS	SS and AS/NZS 3662:2005		≤ 9 to 15 l/kg		≤ 5 to 9 l/min		
Hong Kong WELS	AS/NZS 3662:2005				≤ 9 to 16 l/min		
WaterSense (USA)	ASME and ANSI standards	≤ 4.8 l/flush			5.7 to 7.6 l/min [69]	≤ 5.7 l/min	≤ 1.9 l/ flush
US Energy Star	EPAct 1992, 2005 (*US DoE*)		X	X			

[68] Guidelines for specific product ranges, including testing methodologies and minimum standards of water savings (e.g. pool covers must show a minimum 40% water savings), are currently being developed.

[69] Water performance requirements for showers are estimates under WaterSense the draft specification. Finalised specifications have not yet been decided upon.

Name of Measure	Standards used	Toilets	Washing machine	Dish washer	Shower heads	Taps	Urinals
Singapore Green Label	N/A		≤ 15 l/kg				
Korea Green Label	Korean certification criteria	≤ 5 to 9 l/flush			≤ 9.5 l/min	≤ 7.5 to 9.0 l/min	
Thailand Green Label	Thai Industrial standards	≤ 3 to 6 l/flush	≤ 30 to 35 l/kg	See footnote[70]	≤7.0 l/min		≤ 1.5 l/flush
Japan EcoMark	Japan national standards	≤ 6.5 l/flush				≤ 5 to 8 l/min	≤ 2.5 l/flush

4.5.2.6 Other international initiatives

Other than legislation, standards, and labelling schemes, other initiatives exist that are complementary to existing schemes in that they address surrounding parameters of WuPs and not necessarily the specific WuPs themselves. These programs are important to consider as they demonstrate other ways in which policy makers can address water efficiency standards. This sub-section presents some of these initiatives.

- **Plant Selector Water Drops Rating Scheme (Sydney, Australia) & The Waterwise Garden Irrigator Program (Western Australia)**

The Plant Selector Water Drop Rating Scheme is an initiative operated by Sydney Water (*Sydney Water, 2008*) that allows consumers to make informed decisions about the amount of water plants need. The rating system consists 1, 2 or 3 water drops. The less water drops a plant has the less water it needs. This simple scheme allows the user to input the region and hence determine the plant's suitability for the prevailing climate. Watering requirements will vary according to region and available sunlight. Sydney Water's website includes a database where users can find out more about their region such as average rainfall and common soil type by selecting it on the map legend.

The Waterwise Garden Irrigator Program is an Initiative of the Western Australian Region the Water Corporation. It covers services related to outdoor WuPs (installation of irrigation equipment). Irrigators endorsed under the program are qualified to design and install water efficient garden watering systems to an industry standard. Consumers can also claim a rebate for approved Waterwise products such as subsurface irrigation and rain sensors along with their claim for installation costs. It is administered by WA's Department of Water.

- **Smart Water Application Technologies (US and Australia)**

The SWAT is a partnership initiative of water purveyors and irrigation industry representatives. It covers outdoor WuPs (irrigation equipment), and any irrigation product and/or practice that delivers proven, exceptional landscape water use efficiency, such as smart climate- and soil moisture sensor-based controllers, matched precipitation rate nozzles, flow control nozzles, rain shut-off devices, pressure regulators, multi-stream rotating nozzles, high flow shut-offs, and drip and micro irrigation technologies. It is sponsored by the Irrigation Association (USA).

- **EBMUD Water Service Regulations (San Francisco, CA, US)**

The East Bay Municipal Utility District (EBMUD) serves the eastern portion of the San Francisco Bay Area. The EBMUD Water Service Regulations sets mandatory water efficiency requirements for new businesses that provide water services (installation of toilets, garden irrigation equipment etc.). The following table (Table 67) shows an example of water requirements concerning residential service of indoor water use that service providers must oblige.

Table 67: Water Requirements for Indoor WuPs (*East Bay Municipal Utility District, 2008)*

Toilets	Shall be high-efficiency or dual flush models rated and (third party) tested at a maximum average flush volume of 1.28 gallons per flush (gpf), and be certified as passing a 350 gram or higher flush test as established by the Uniform North American Requirements or other District-accepted third party testing entity. No flush or conversion devices of any other kind shall be accepted.
Showerheads	Shall be individually plumbed and have a maximum rated flow of 2.5 gallons per minute or less and be limited to one showerhead per shower stall of 2,500 sq. inches in area or less. Installation of flow restrictors in existing showerheads does not satisfy this requirement.
Lavatory faucets	Shall have aerators or laminar flow control devices (i.e. orifices) with a maximum rated flow of 1.5 gallons per minute or less.
Kitchen faucets	Shall have aerators or laminar flow control devices (i.e. orifices) with a maximum rated flow of 2.2 gallons per minute or less.

EMBUD also provides information on devices to help them save water and rebates for installing water-efficient toilets, washing machines, and landscapes. Commercial customers may qualify for rebates for installing water-saving fixtures or equipment or for increasing the efficiency of on-site water use including water-using manufacturing processes.

4.6. TECHNICAL AND TEST STANDARDS AND PRODUCT TESTING PROCEDURES

Internal regulations from the European Committee for Electrotechnical Standardisation (CENELEC) define a standard as a document, established by consensus and approved by a recognised body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Standards should be based on consolidated results of science, technology and experience, and be aimed at the promotion of optimum community benefits. The European EN standards are documents that have been ratified by one of the three European standards organizations, the European Committee for Standardisation (CEN), the CENELEC or the European Telecommunications Standards Institute (ETSI).

A "test standard" is a standard that sets out a test method, but that does not indicate what result is required when performing that test. Therefore, strictly speaking, a test standard is different from a "TS". Namely, in technical use, a standard is a concrete example of an item or a specification against which all others may be measured or tested. Often it indicates the required performance.

However, "test standards" are also (but not exclusively) defined in the "TS" itself. For example, a European standard for a certain product or process gives the detailed technical specifications, which are required in order to conform to this standard. It also defines test standards (or rather methods) to be followed for validating any such conformity. A standard can be either product or sector specific, and it can concern different stages of a product's life cycle. In addition to "official" standards, there may be other sector specific procedures for product testing, which could be considered as standards when they have been recognised both by the sender and the receiver, that is, when they are using the same parameters or standards. Those procedures are discussed later in this chapter.

Any product-oriented legislation should preferably refer to harmonised (EN) test standards in order to verify the compliance with set measures. The referenced test standard should be accurate, reproducible and cost-effective, and model as accurately as possible the real-life performance. If no suitable test standard exists, they need to be developed (possibly based on existing sector specific procedures) for the relevant parameters in the view of implementing measures. Standards related to the water performance of different WuP and relevant for this study are presented below.

4.6.1. European (EN) standards

Workshop and Technical Committees are the bodies in charge of the elaboration of standards for a specific group of products or services. The activity of the European Technical Committees indicated in Table 68 is interesting in the context of our study.

Table 68: European Technical Committees of standardization dealing with key WuPs

Technical Committee	Description	Products concerned
CEN/TC 163 – Sanitary appliances	This committee deals with sanitary appliances used in all civil, industrial and commercial	Toilets

	building for personal hygiene (or for preparation of food, the washing of dishes and the discharge of domestic waste water in case of kitchen sinks)	
CEN/TC 164 – Water Supply	This technical committee is involved in a broad range of subjects, dealing with all the drinking water supply chain, from systems to accessories, including chemical products, and addressing both public installations and inside building equipments	Taps, showerheads,

Standards developed in these committees generally aims at harmonising technical characteristics, quality or sanitary requirements of products. They rarely directly deal with water efficiency of WuPs, however some specifications might influence it. Table 69 goes over the main points of European Standards related to water performance of some classic WuPs. For every requirement, the test procedure is usually specified in the standard.

Table 69 : European Technical and Test Standards dealing with water efficiency of key WuPs

<table>
<tr><th>European Standards</th><th>Products concerned</th><th>Requirements or element in relation with water efficiency</th></tr>
<tr><td>EN 997:2003</td><td>Toilets</td><td>A maximum flush volume of six litres for pressure flushing valve WCs and a reduced flush no greater than two-thirds of this volume for dual-flush WCs. For classical WC, the nominal flush volumes defined by the standard ranges between 4 to 9 litres.</td></tr>
<tr><td>prEN 14055:2007</td><td>Toilets</td><td>
<table>
<tr><th rowspan="3">Nominal volume (l)</th><th colspan="4">Flush volumes (l)</th></tr>
<tr><th colspan="2">Complete flushing</th><th colspan="2">For water saving (dual) flushing</th></tr>
<tr><th>Minimum</th><th>Maximum</th><th>Minimum</th><th>Maximum</th></tr>
<tr><td>9</td><td>8,5</td><td>9</td><td>3</td><td>4,5</td></tr>
<tr><td>7</td><td>7</td><td>7,5</td><td>3</td><td>4</td></tr>
<tr><td>6</td><td>6</td><td>6,5</td><td>3</td><td>4</td></tr>
<tr><td>5</td><td>4,5</td><td>5,5</td><td>3</td><td>4</td></tr>
<tr><td>4</td><td>4</td><td>4,5</td><td>2</td><td>3</td></tr>
</table>
The devices must deliver flush volumes and flush flow rates in accordance with table below, and comply with the following requirements:
• Double-action mechanisms (interruptible):
- one action initiates flushing and
- a second action stops the flush.
(Devices with immediate and automatic closing are not permitted)
• Double-control mechanisms (dual control):
- one control releases the full flush volume and
- another control releases a reduced flush volume.
</td></tr>
<tr><td>EN 200:2008</td><td>Single and Combination Taps</td><td>Fixes minimum flow rates according to application. Basin, bidets and sinks water saving taps shall deliver flow rate between 4-9 l/min.</td></tr>
<tr><td>EN 246:2003</td><td>Flow Rate Regulators</td><td>Defines classes according to the flow rate of the regulator, the lower class (class Z) corresponds to a 9 l/min flow rate regulator (at 3 bar)</td></tr>
<tr><td>EN 817:2008</td><td>Mixing valves for taps</td><td>Fixes minimum flow rates according to application. Basin, bidets and sinks water saving taps shall deliver flow rate between 4-9 l/min.</td></tr>
<tr><td>EN 60456:2005</td><td>Washing machines</td><td>Methods for measuring the performance of residential washing machines. Stipulates that shall use less than or equal to 12 litres of water per kg of wash load measured (Standard 60°C cotton cycle)</td></tr>
<tr><td>EN 50242:2008</td><td>Dish washers</td><td>Methods for measuring the performance of residential dish washers. Stipulates that shall use less than 1.2 litres per place setting.</td></tr>
</table>

The list of standards provided in Table 69 is not exhaustive; other standards might influence the water efficiency of some WuPs. The standards which are used in some of the identified schemes are shown in Table 70.

Table 70 : Schemes and related test standards

Test Standards	Products covered	Schemes
EN 997:2003 - WC pans and WC suites with integral trap	WC suites designed for use with a pressure flushing valve or a flushing cistern incorporating some other flushing device	BMA Water Efficiency Labelling scheme (United Kingdom)
EN 50242:2008 – Electric dishwashers for household use. Methods for measuring the performance	Household dishwashers	Nordic eco-label
		European Eco-label
PrEN 14055 - WC and urinal flushing cisterns	WC and urinal flushing cisterns with flushing mechanism, inlet valve and overflow	BMA WELS (United Kingdom)
		Water Efficiency Rating Scheme (Certificação da Eficiência Hídrica de Produtos) (Portugal)
EN 60456:2005. Clothes washing machines for household use. Methods for measuring the performance	Clothes washing machines	European Eco-label

4.6.2. COUNTRY-SPECIFIC TECHNICAL AND TEST STANDARDS

Australian Standards

The Australian WELS is based on the Water Efficiency Labelling and Standards Act 2005 (AS/NZS 6400:2005). The WELS standard sets out criteria for rating the products in relation to either or both of the following:

- water efficiency;
- general performance; and
- requirements in relation to communicating such ratings on product labels.

The WELS standard is also cross-referenced to the performance requirements of other product standards and technical specifications. The following table (Table 71) lists these product standards and technical specifications, as well as the schemes on which they are based on:

Table 71 : Australia Test Standards and Technical Specifications

Test Standards/Technical Specifications	Products covered	Schemes
AS/NZS 3662:2005 - Performance of showers for bathing	Showers intended solely for personal bathing	Australian WELS
		Hong Kong WELS
		Singapore WELS
AS/NZS 3718:200 - Water supply-Tap ware	Any tap for use over	Australian WELS

Test Standards/Technical Specifications	Products covered	Schemes
	a basin, ablution trough, kitchen sink or laundry tub as specified in	
ATS 5200.037.2-2005-Technical Specification for plumbing and drainage products, Part 037.2: Flow controllers-For use in heated or cold water plumbing systems.	Flow controllers	Australian WELS
- AS 1172.1-2005, WC, Part 1: Pans *- AS 1172.2-1999, WC pans of 6/3 L capacity or proven equivalent, Part 2: Cistern* *- ATS 5200.021-2004, Technical Specification for plumbing and drainage products, Part 021: Flushing valves for WS and urinals-For use with break tank supply* *- ATS 5200.020-2004, Technical Specification for plumbing and drainage products, Part 020: Flushing valves for WS and urinals-For use with mains supply and* *- ATS 5200.030-2004, Technical Specification for plumbing and drainage products, Part 030: Solenoid valves.*	Toilets , toilet suites, pans, cisterns, flushing devices and combinations of these products	Australian WELS
- AS/NZS 3982:1996, Urinals and *- ATS 5200.004-2005, Technical Specification for plumbing and drainage products - Urinal flushing cisterns.*	Urinals: urinal suites, urinals, urinal flushing control mechanisms and combinations of these products	Australian WELS
AS/NZS 2040.2:2005 - Performance of household electrical appliances-Clothes washing machines, Part 2: Energy labelling requirements.	Electric washing machines intended for household or similar use	Australian WELS
AS/NZS 2007.2:2005 - Performance of household electrical appliances-Dishwashers, Part 2: Energy labelling requirements.	Dishwashers	Australian WELS

- **USA standards**

In the United States, there are national efficiency standards and specifications for residential and commercial water-using fixtures and appliances. These stem from the Energy Policy Act of 1992 (EPAct 1992) amended the National Energy Conservation Policy Act (NECPA) and established several energy management goals. Section 152 of EPAct 1992 amended NECPA by adding water conservation and the use of renewable energy to the energy efficiency requirements outlined in Section 542. The EPAct 1992 also amended Section 543 of NECPA by removing "goals" and inserting "requirements". Several amendments were made in 2005 (*Energy Policy Act of 2005).*

In addition to EPAct efficiency requirements, the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI) also set standards for certain products. Table 72 lists ASME and ANSI test standards and specifications for which the US WaterSense program is based on.

Table 72 : US test standards and technical specifications

Test Standards/Technical Specifications	Products covered	Schemes
A112.18.1 - 2005/CSA B125.1-05 Plumbing Supply Fittings note: This joint Standard was developed in response to an industry request for a Standard for testing plumbing supply fittings that would be acceptable in both Canada and the United States. *NSF/ANSI Standard 61, Section 9*	Public wash basin taps	WaterSense
ASME and the ANSI national standard A112.19.6-1990, Hydraulic Requirements for WC and Urinals *ASME A112.19.2* *ASME A112.19.14*	Toilets and Urinals Single flush toilets Dual flush toilets	WaterSense
ASME A112.18.1-2005/CSA B125.1-05	Showerheads	WaterSense

- **Thai Standards**

The Thai Green Labelling Scheme is based on Thai industrial standards established by the Thai Industrial Standards Institute (TISI). See the following table (Table 73) for the TSI standards that this scheme is based on.

Table 73: Thailand Test Standards and Technical Specifications

Products covered	Test Standards/Technical Specifications
Toilets	*TISI 792, Standard for Vitreous China Sanitary Appliances : Water-Closet Bowls;* *TISI 794, Standard for Vitreous China Sanitary Appliances : Squatting Water-Closet Pans;* *TISI 1014, Standard for Fittings for Water-Closet Flushing Cisterns;* *TISI 1093, Standard for Flush Valves for Water-Closets;*
Washing Machines	*TISI 1462 , Washing Machines*

Products covered	Test Standards/Technical Specifications
Taps, Rinsing Sprays, and Shower-heads	*TISI 1189, Standard for Faucets For Showers* *TISI 1277, Standard for Sinks* *TISI 1278, Standard for Wash Basins* *TISI 1377, Standard for Self-closing Faucets For Wash Basins* *Standard for automatic faucets for sanitary accessory conform to TISI : automatic faucets for sanitary accessory.* *TISI 1187, Standard For Shower* *TISI 1094, Standard For Flush Valves For Urinals* *TISI 1497 , Standard For Rinsing Sprays*

- **Korean test standards**

According to the Korean eco-label program, products are tested according to specific test methods and standards. The following figures show the certification criteria (environmental and quality) that products must fulfil to obtain the Korea eco-label. Figure 69 shows test methods for taps under the Korea eco-label.

Figure 69: Test Methods for Taps under the Korea eco-label

Certification Criteria			Test and Verification Methods
Environmental Criteria	3.1.1		• Test report by an accredited testing laboratory in accordance with 3.1.1.1, 3.1.1.3, 3.1.1.4, 3.1.1.5.1: KS B 2331(faucet) • Test report by an accredited testing laboratory in accordance with 3.1.1.2.2: 'Test Methods 4.1 and 4.2.' • 3.1.1.2.1, 3.1.1.5.2~3: Verification of submitted documents
	3.1.2	3.1.2.1	Test report by an accredited testing laboratory in accordance with the test methods 4.1 and 4.3.'
		3.1.2.2	Verification of submitted documents
		3.1.2.3	Test report by an accredited testing laboratory in accordance with the test methods 4.1 and 4.4.'
Quality Criteria	3.2.1		Test report by an accredited testing laboratory in accordance with KS B 2331 (faucet) or certificate of equivalent
	3.2.2 ¯ 3.2.4		Verification of submitted documents
Consumer Information			Verification of submitted documents

Note2) Valves with the function of instantaneous shut-off /self-closing/quantitative shut-off shall be tested and verified respectively in accordance with instantaneous shut-off /self-closing/quantitative shut-off faucet

Figure 70: Test methods for toilets under the Korea eco-label

Certification Criteria		Test and Verification Methods
Environmental Criteria	3.1.1	Test report by an accredited testing laboratory in accordance with the test methods 4.1 and 4.2
	3.1.2	Verification of submitted documents
Quality Criteria	3.2.1	Test report by an accredited testing laboratory in accordance with the test methods 4.1 and 4.3
	3.2.2	Test report by an accredited testing laboratory in accordance with KS L 1551 (hygiene ceramic ware) or the equivalent certificate
Consumer Information		Verification of submitted documents

- **Singapore Standards**

Under the Singapore WELS, the Singapore test standards and technical specifications specified in Table 74 are used for toilet and taps.

Table 74 : Singaporean TS and technical specifications

Products Covered	Singapore Testing standard or Technical Specification
Toilets	**SS 378: 1996** Specification for low capacity WC flushing cisterns up to 4.5 litres maximum **SS 379: 1996** Specification for vitreous china WC pans for use with low capacity WC flushing cisterns up to 4.5 litres maximum
Taps (Showers, basins, and sinks	**SS 448: 1998** (Part 3-Hydraulic characteristics): Performance of draw-off taps with metal or plastic bodies for water services. Specifies the dimensional, water tightness, pressure resistance, hydraulic, mechanical strength and mechanical endurance characteristics of nominal size 1/2 and 3/4 single and combination taps.

- **Japanese Standards**

The Japan EcoMark is based on the Japan national standards specified in Table 75.

Table 75 :Japan test standards and technical specifications

Products Covered	Japan Testing standard or Technical Specification
Urinals	JIS A 5207: Structural criteria for urinals and washing/discharge performance
Flush toilets	JIS A 5207: Washing/discharge performance for flush toilets
Taps	JIS B2061 Faucets, ball taps and flush valves: discharge volume

4.6.3. OTHER SECTOR-SPECIFIC PROCEDURES FOR PRODUCT TESTING

- **Unified North American requirements for toilet fixtures**

UNAR is a voluntary qualification system adopted by water authorities that believe it is critical to:

1) achieve sustainable water savings from toilet fixture replacements, and 2) ensure a high level of customer satisfaction with flushing performance.

UNAR combines elements of two successful toilet fixture testing programs: Maximum Performance (MaP) testing (*Gauley et al., 2006*) and the Los Angeles Supplementary Purchase Specification (SPS) requirements2.

The UNAR specification is supplementary to the minimum requirements established within the following national standards:

- American Society of Mechanical Engineers A112.19.2-2003 and A112.19.5-2005
- Canadian Standards Association B45 Series-02, Plumbing Fixtures

UNAR encompasses two tiers of performance:

(a) Conventional toilet fixtures flushing at 1.3 to 1.6 gallons and,
(b) HETs flushing at 1.28 gallons or less.

- **Toilet performance testing: MaP**

The MaP testing project was undertaken in 2003 in order to identify how well popular toilet models perform using a realistic test media. The testing protocol, cooperatively developed by water-efficiency and plumbing fixture specialists in the U.S. and Canada, incorporated the use of soybean paste as a test media, closely replicating the "real world demand" on fixtures. Performance testing of 80 different toilet fixture models was completed and summarised in the Final Report of December 2003 (*Alliance for Water Efficiency, 2003*).

Now in its 13th edition, the current MaP testing report provides performance information on over 842 different toilet fixture models. Many of these models are WaterSense-rated HETs.

4.7. CHAPTER KEY ELEMENTS

Summary of key elements in relation to existing standards, schemes, programs, and other instruments that regulate the water performance of WuPs

At the EU level, very few pieces of legislation and policy measures introduce water efficiency requirements. Moreover, the coverage of WuPs is very limited, mainly addressing products with significant energy consumption.

At the national level, different initiatives exist within Europe and in third countries (e.g. Unites States, Australia) introducing water efficiency requirements, particularly for residential and commercial WuPs such as showers, dishwashers, washing machines, urinal operating mechanisms, taps and tap outlets, toilet suites and matching-set cisterns, and flow regulators.

Most commonly, water efficiency requirements are associated to a labelling scheme, either on a certification or ranking system basis (e.g. WELS in Australia, WaterSense in the United States, or the Waterwise Marque in the United Kingdom).

Many MS do operate eco-labels, such as the Blue Angel in Germany and the Swan in the Nordic countries, which are awarded to products for overall eco-friendliness and sometimes consider water consumption. These labels tend to focus on sustainable materials use or the minimisation of pollution and usually exclude most important WuPs such as taps or flushing toilets.

At the international level, most initiatives that regulate water performance of WuPs exist in the United States, and several countries in the Asia-Pacific region. The concept of WELS is quite prevalent in these areas (expect in the USA) and is in different stages of development and implemented in several forms overseas (Australia, Singapore, New Zealand, and Hong Kong). In some countries, it is a mandatory requirement to provide water efficiency labels for certain WuPs before they can be put on the market. For others, the WELS is on a voluntary basis so as to allow a lead time for the market to transform towards more water efficient products (as is in the case of Hong Kong and certain products under the Singapore WELS).

Technical and test standards defined by normalisation bodies are tools to harmonise the technical specifications of products. Although they are not mandatory by themselves, regulations or voluntary schemes can rely on them.

Policy measures are usually not implemented as isolated measures but as part of a mix of instruments in order to increase the intended effects. Information measures, for instance, are frequently combined with other instruments because people need to gain an awareness and knowledge of a certain problem area in order to stimulate a change in behaviours and practices. For example, product labelling schemes (information) are frequently based on MPS (regulation).

5. IMPACTS OF EXISTING POLICIES

5.1. INTRODUCTION

The main objective of this chapter is to analyse the major synergies and inconsistencies in existing water standards that were identified in chapter 4. This analysis focuses on existing standards in Europe, as well as the coherence, overlaps, and inconsistencies of standards existing at different scales (local, regional, national, and international) with the aim of developing a better understanding of the strengths, weaknesses and relevance of current policy instruments to inform the formulation of future water efficiency initiatives at a European level.

The assessment of the gaps and limitations of existing policy measures will identify which technical aspects of WuPs should be addressed in priority and identify further research needs. Evaluation of the impacts of existing initiatives will serve to determine the effectiveness of existing schemes. This chapter would involve highlighting these issues with some real-life case-studies which would cover good examples of existing standards that have proven to be efficient in improving water performance of WuPs.

Based on this analysis, it would be possible to identify possible barriers and potential solutions when introducing water specific standards for WuPs within Europe, which is addressed in chapter 6.

This analysis focuses particularly on regulatory, voluntary and informational instruments or combinations thereof[74]. In particular, this analysis pursues the following three objectives:

- To characterise key features, identify gaps and inconsistencies of current water efficiency policy instruments aimed at WuPs,
- To investigate the outcomes, impacts and failure/success factors of existing policy instruments, and
- To explore and discuss on the basis of the previous analysis, benefits and limitations of the investigated instruments for increasing water efficiency of WuPs.

Before presenting the results of this investigation and drawing conclusions for policy-makers, a general introduction to the investigated types of water efficiency policy measures is provided and the methods adopted throughout this analysis are briefly outlined. It should be noted that the terms policy measures and instruments are used interchangeably throughout this report. Following Vreuls (2005), we define policy measures and instruments as political actions or market interventions

[74] Appendix 1 presents a general overview of policy instruments.

designed to persuade water consumers to reduce water use and encourage market parties to promote water efficient products and services.

5.2. ASSESSMENT APPROACH

It is widely agreed that that the evaluation of policy effects is a challenging task and the success of (environmental) policy instruments must ultimately be judged in terms of environmental improvements (*UNEP, 2005 b*). In the context of this study this would mean establishing the amount of water saved by introducing a specific policy measure. A study by UNEP (ibid.) on the effectiveness of ecolabelling programmes highlights that three specific categories of information are necessary to determine the effectiveness of policy interventions:

- Data is needed on the environmental effectiveness of the policy measure itself (i.e. in this case data showing the amount of water saved when compared to a baseline).
- Data is needed which not only provides information on the effectiveness of a policy measure but also generates insight into the reasons for success or failure.
- Data is needed which allows the assessment of the relative effectiveness of one (type of) policy measure in comparison with competing (types of) instruments (i.e. information on the same evaluation indicators and measures and using the same units of analysis).

However, our investigations failed to identify a substantial body of evidence to allow us to draw any confident conclusions on the relative effectiveness of any of the investigated initiatives. Data is largely qualitative and anecdotal and there is hardly any baseline data available against which to compare potential policy impacts. Where water savings are attributed to the introduction to specific policy interventions, they are largely based on projections rather than actual savings, making it difficult to judge their impact. Furthermore, inconsistencies between evaluation methods complicate the comparison of impacts. The analysis is further handicapped by the fact that policy measures vary in the types and range of products covered.

Against this background, the research team adopted a comprehensive assessment strategy, drawing strongly from recent developments in theory-based policy evaluation methodologies rather than simply focusing on impacts only, i.e. on water savings and costs. Theory-based policy evaluation tries to conceptualise how a policy instrument (or a package of instruments) is expected to lead to efficiency improvements. Both qualitative and quantitative data can be used to investigate each aspect of the policy 'theory', thus identifying key steps and bottlenecks of the design and implementation of different types of policy interventions. However, given the limitations outlined above, the analysis presented in this study will largely draw from qualitative and anecdotal data for a discussion on study limitations and future work). By focusing on the whole policy process, we aim to generate insight into the mechanisms and success or failure factors of different policy instruments thus helping to design new measures and improve existing ones (*Blumstein et al., 2000; Vreuls 2005; Khan et al., 2006*). Adopting a theory-based approach allows us:

- To develop instrument-specific indicators which take into the mechanisms by which they are intended to bring about change,
- To develop insights into the implementation process and identify barriers and facilitators of success,
- To evaluate instruments in all implementation stages by developing cause-impact chains and proximate objectives for each link in the chain.

Whilst theory-based evaluations are increasingly popular in the field of energy policy, to our knowledge, they have not been applied to water efficiency policy instruments. Drawing from these recent experiences *(Vreuls 2005; Khan et al., 2006),* the evaluation process was carried out in two steps:

1. Initial characterisation of policy measures: In order to specify the assessment focus and select indicators, objectives and target groups were identified and cause-effect relationships were mapped for each instrument.
2. Specification of assessment focus, indicators, and success and failure factors: the characterisation provided the basis for specifying the assessment focus, selecting responding indicators and identifying failure and success factors for each instrument. Based on existing literature *(Vreuls 2005; Khan et al., 2006; Gupta et al., 2007)* data availability, and taking into account the timeframe for which most of the schemes have been in operation, the research team agreed to cover outcomes and impacts, as well as facilitators and barriers of policy success.

Outcomes are the changes or improvements for individuals, groups or organisations which directly result from a policy instrument. They include short-term effects such as a change in knowledge or attitudes as well as intermediate outcomes such as a change in behaviours, decisions and actions. For example, the introduction of a water efficiency labelling scheme might create an increased awareness among customers and encourage them to buy more water efficient products (short-term outcome). Eventually, the market share of water efficient product models will increase (long-term outcome) resulting in water savings (impact). For the assessment of the effectiveness or **impacts** of environmental policy instruments, the literature distinguishes between environmental effectiveness, socio-economic impacts (distributional consequences) and institutional feasibility *(Gupta et al., 2007).* This analysis will focus on assessing the actual or potential water savings (depending on data availability) resulting from each instrument. Socio-economic and institutional aspects will be discussed when examining the **facilitators of and barriers** for policy success. These can be broadly grouped into the following categories (*Khan et al., 2006; GTZ et al., 2006; Gupta et al., 2007*):

- Technical barriers: technology may not be sufficiently advanced yet to adequately respond to policy requirements.
- Knowledge / information barriers: Actors may not be informed about possibilities for water efficiency improvement or the extent to which the technology might be applicable to them.
- Economic barriers: Producing new technologies might not seem profitable to manufacturers or result in unbalanced or unfair distribution of benefits and costs.
- Institutional barriers: Institutional set-up inevitably influences policy implementation and enforcement. Important factors include human capital, infrastructure and knowledge. Moreover, certain policy instruments work well in one situation due to institutional familiarity or existing organisational structures, whereas in another context, authorities struggle with the practical implications of particular instruments.
- Lack of interest in water efficiency improvement: Companies, organisations and households tend to neglect issues and problems which do not directly affect their everyday life or business. Coupled with (comparatively) low costs for water supply and consumption in many European countries, they will not spend much effort on reducing their water consumption.
- Policy context: Information on the policy context of the instrument can help to explain the success of failure of its implementation. The main characteristics of the general environmental or water policy, the general status of environmental concerns on the political agenda and the political support for water efficiency initiatives can be crucial determinants of an instruments success.

As illustrated earlier, this analysis mainly draws from published information on the schemes as well as (limited) questionnaire and survey data. It should be noted that data availability largely varies between investigated instruments, implying that not all initiatives will be analysed to the same level of detail. Moreover, considering the relative recent establishment of the majority of water efficiency measures, the assessment focuses in many cases on outcomes rather than impacts as well as the early experiences of implementing and operating these measures.

5.3. CHARACTERISATION OF POLICY MEASURES AND INDICATORS' SELECTION

Having established the general assessment strategy adopted, this sub-section characterises the investigated policy measures and formulates instrument-specific indicators. It should be noted that, whilst the inventory of existing schemes in chapter 4 differentiates between mandatory and voluntary measures, this initial characterisation is organised along the three types of policy measures included in the assessment: regulatory instruments, information instruments and voluntary agreements.

5.3.1. Regulatory measures

The term 'regulation' refers to rules and regulations that require certain devices, practices, or system designs to improve water efficiency. Regulatory instruments in general are thought to be highly effective in achieving their objectives. However, this success relies heavily on an effective enforcement and control system with sufficient capacities to implement and ensure compliance with any legal requirements, possibly by using penalties (*GTZ et al., 2006*; *Khan et al., 2006*). Minimum Performance Standards (MPS) or Technical Standards (TS) are relatively easy to formulate and enact. It is crucial to ensure that standards are based on an extensive knowledge base and to consult the affected interest groups throughout the development process. Whilst mandatory (national) standards have the benefit of creating equal conditions for all businesses, they incur comparatively higher costs than, for example, economic instruments. Ensuring a balanced distribution of costs and benefits is thus key to achieving success. One of the drawbacks of mandatory standards is that they offer little incentive for innovation. They have to be constantly revised and updated, to ensure that companies move beyond existing standards which, again, relies on sufficient human and organisational resources of the responsible authority. Finally, regulations need to be coherent with other policy measures in order to achieve the intended impacts *(GTZ et al., 2006).*

The two main subcategories of regulation policy measures for water efficiency include building codes and MPS. Each of these subcategories will be discussed in separate sub-section below.

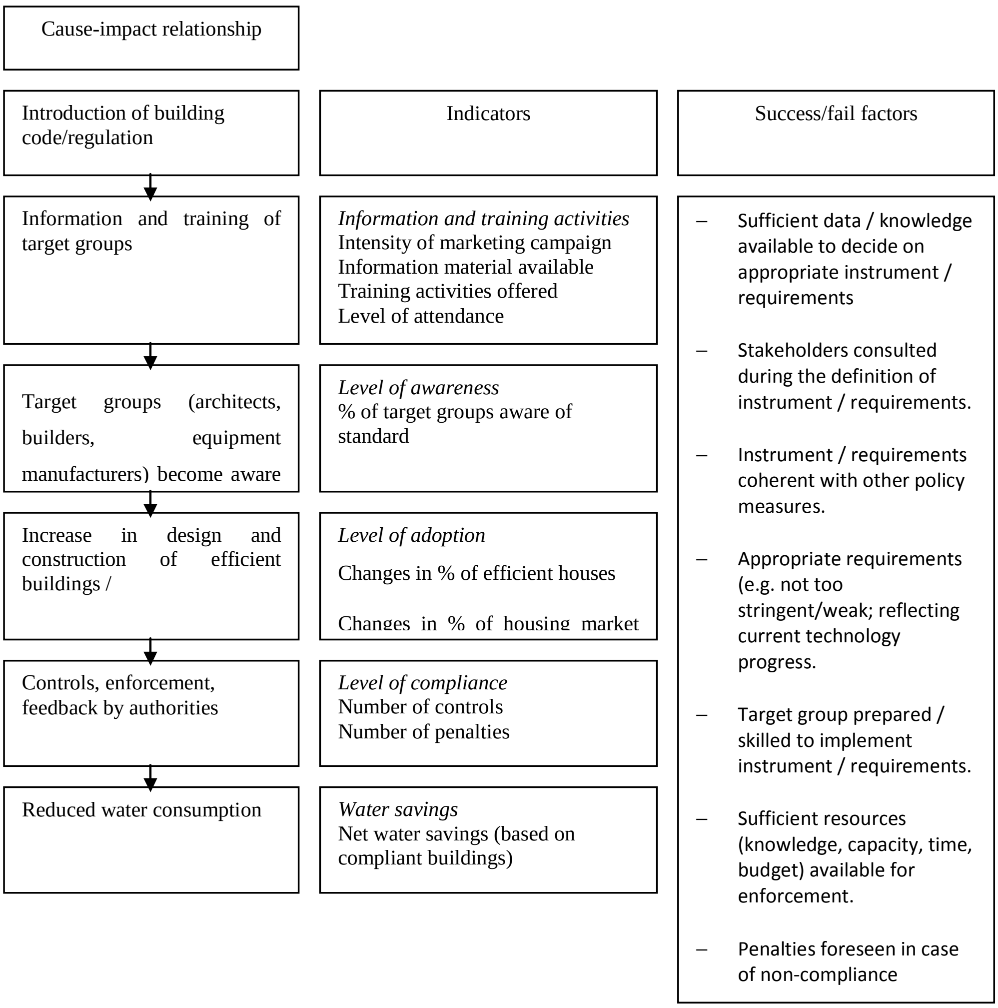
- **Building codes/regulations**

Building codes specify how buildings (or subsystems of buildings) must be constructed or perform. Most codes apply to both residential and non-residential (commercial) buildings, although the exact requirements usually differ for the various categories of buildings. Building codes can vary in the methodology they adopt to increase the water efficiency of buildings, either by setting a performance benchmark for the whole building or by specifying efficiency levels for key fittings. The theory underlying the building codes assumes that architects, builders, and producers of building equipment will apply water saving measures in their designs and constructions. Local authorities will need to appoint building inspectors to ensure they comply with the code. The code must ensure that the buildings with the worst water performance can no longer be constructed, usually only applying to new buildings, though, not the existing stock. Based on these identified effects, outcome and impact indicators can be divided into the following categories (*Vreuls, 2005*):

- Level of awareness and knowledge.
- Level of adoption of practices.
- Level of enforcement and compliance.
- Changes in water consumption of buildings.

Figure 71 shows the cause-impact relationships, indicators, and success/failure factors for buildings codes.

Figure 71: Building codes: Cause-impact relationships, indicators, success/failure factors



Mandatory Performance Standards

There are two basic types of efficiency standards: technology standards and performance standards. Technology standards require that a particular feature or device is installed in all new products. Performance standards prescribe a minimum efficiency (or maximum consumption) that manufacturers must achieve in each product. Within the context of water efficiency, technology standards are often part of building code requirements, and are less flexible than performance standards, as the latter do not specify the technology or design details of a product, only the minimum performance (*Gupta et al., 2007*). This analysis focuses on mandatory minimum/maximum performance standards. As stated above, the mandatory performance standard imposes minimum water efficiency rating or maximum water consumption for all products on the market, and prohibits the sale of equipment that is less efficient than the minimum level. The standard usually includes a protocol or test procedure that prescribes how to measure and rank the water efficiency of a particular product which all producers will have to use to verify that their models comply with the standard (*Vreuls, 2005*). Other stakeholders that play a role are the end-users of the low-efficiency models and those charged with ensuring and enforcing compliance with the standard. If the standard is accompanied by labelling and other measures, retailers and importers may also indirectly be affected (see below). The outcome of the performance standards consists of an increased production of low-efficiency product models. Eventually, a change in the market share will lead to the desired reduction in end-use water consumption. It should be highlighted that these outcomes should become visible on the market much sooner than, for example, the outcome of building codes due to the relatively short lifespan of the appliances. Indicators that can be used to assess the outcomes and impacts of performance standards include:

- Changes in the level of awareness and knowledge.
- Changes in the adoption levels of practices in designs and models of the product.
- Changes in water consumption.

Figure 72 shows the cause-impact relationships, indicators, and success/failure factors for performance standards.

Figure 72: Performance standards: Cause-impact relationships, indicators, success/failure factors

Cause-impact relationship	Indicators	Success/fail factors
Introduction of performance standard		
Information and training of target groups	*Information and training activities* Intensity of marketing campaign Information material available Training activities offered Level of attendance	– Sufficient data / knowledge available to decide on appropriate instrument / requirements – Stakeholders consulted during the definition of instrument / requirements. – Instrument / requirements coherent with other policy measures. – Appropriate requirements (e.g. not too stringent/weak; reflecting current technology progress. – Target group prepared / skilled to implement instrument / requirements. – Costs and benefits equally distributed.
Target groups (manufacturers, retailers) become aware of water efficiency and standard	*Level of awareness* % of target groups aware of standard	
Increased production of efficient product models.	*Level of adoption* Changes in % of efficient product models produced	
Consumers buy more efficient products	*Level of behavioural change* Changes in % of market share	
Reduced water consumption	*Water savings* Net water savings (based on market share)	

5.3.2. INFORMATION MEASURES

The majority of existing water efficiency measures falls into the information category. In general the objectives of information policy measures and programmes are to:

- Increase the awareness of consumers, manufacturers, retailers, architects and engineers of water-efficient products and services, as well as their economic and environmental benefits.
- Persuade consumers and retailers to adopt water efficient products and practices.
- Provide retailers and consumers with the technical information they need to identify and adopt energy efficient products and practices.

Information measures cover a spectrum of very diverse instruments, including information centres and campaigns, environmental auditing and reporting systems or product markings. This analysis focuses specifically on the following two sub-categories: labels and certificates. One of the key strengths of these information instruments is their potential to increase the awareness of both the consumer and the manufacturer of water efficiency issues, thus contributing to changes in both purchasing behaviours and production patterns. Factors which promote the success of labelling or certification schemes include the consultation of stakeholders and credibility of the sponsoring or certifying agency. Furthermore, the intensity of information provided plays an important role in fostering the public's trust in product information schemes (*Vreuls, 2005; GTZ et al., 2006*). It should be noted that whilst the marketing opportunities of product information schemes (positive image of manufacturers) encourage ambitious companies to commit to producing more water efficient products, it might hinder the innovation process. If efficiency criteria are not continuously evaluated and updated, there is little incentive for manufacturers to improve performance beyond the specification of current standards (*GTZ et al., 2006*). Furthermore, public authorities need to be aware of the resources involved in establishing labelling or certification schemes, both for the manufacturer as well as the responsible authority: firms may have to collect and disseminate information they would not otherwise have gathered, and government agencies must be able to verify the information. Since firms may view information policies as overly burdensome and argue that voluntarily provided information is sufficient (*Sterner, 2003*), it is crucial to consult the affected target group prior to establishing any information scheme, in order to define appropriate and feasible measures.

Since there is little difference between labels and certificates in terms of the target groups they address and the mechanisms they employ, the subsequent sub-section will describe these instruments together.

- **Labels and certificates**

Labels and certificates are markings indicating the water efficiency of a certain product or service, in order to provide information to consumers. They are aimed at stimulating both supply and demand of products with improved resource efficiency (*GTZ et al., 2006*). Labelling schemes usually use a rating system to indicate the level of efficiency of a particular model. In contrast, certificates are quality marks which are affixed only to models meeting or exceeding a certain efficiency level. Both instruments can be either voluntary or mandatory and are frequently combined with performance standards. On the demand side, it is assumed that environmental characteristics are important product attributes about which consumers need to be given explicit information in order to make more rational purchasing decisions. Provided with this information, customers are more likely to factor water costs or environmental concerns in general into their decisions, and to purchase products that have lower overall costs (typically being more resource efficient) than they would otherwise. With respect to supply, a label has the objective of encouraging businesses to produce and sell more efficient or environmentally friendly products. By including resource efficiency in the appearance of products and influencing consumer buying decisions, labels motivate manufacturers to develop, produce, and market more efficient products. As less water efficient products are slowly replaced, the water consumption is expected to decrease at the consumer level (*IEA, 2000; GTZ et al., 2006*). Indicators of outcomes and impacts for labels and certificates can focus on:

- Changes in customer awareness levels and attitudes towards energy efficiency.
- Changes in purchasing behaviour
- Adoption (change of behaviour) of the targeted practices and products.
- Change in water consumption at the consumer level

Figure 73 shows the cause-impact relationships, indicators, and success/failure factors for labelling and certification schemes.

Figure 73: Labelling and certification schemes: Cause-impact relationships, indicators, success/failure factors

Cause-impact relationship	Indicators	Success/failure factors
Introduction of labelling/certification scheme ↓		
Information and training of target groups ↓	*Information and training activities* Intensity of marketing campaign Information material available Training activities offered Level of attendance	– Sufficient data / knowledge available to decide on appropriate instrument / requirements – Stakeholders consulted during the definition of instrument / requirements. – Instrument / requirements coherent with other policy measures. – Appropriate requirements (e.g. not too stringent/weak; reflecting current technology progress. – Target group prepared / skilled to implement instrument / requirements. – Costs and benefits equally distributed.
Manufacturers, retailers and consumers become aware of code ↓	*Level of awareness* % of target groups aware of scheme	
Increased production of efficient product/ Range of water efficient product models offered by retailers increases ↓	*Level of adoption* Changes in % of efficient product models produced / promoted by retailers Number or % of products labelled	
Increased purchasing of efficient products ↓	*Behavioural change* Changes in % of market share	
Reduced water consumption	*Water savings* Net water savings (based on market share)	

5.3.3. Voluntary agreements

Voluntary agreements are multi-party programmes aimed at reducing water consumption of a single firm, groups of companies or industrial sectors, usually defined according to their industry branch or sector. Voluntary agreements can be grouped into three sub-categories (*GTZ et al., 2006*):

- Unilateral agreements made by industry: In unilateral commitments, individual companies, groups of firms from the same sector or industry associations establish their own environmental goals. They determine specific actions to reach their goals and control any monitoring or public reporting process. These initiatives, which usually go beyond existing environmental requirements, can help raise industry standards and provide benchmarks for other companies that are not party to the agreement.
- Agreements between industry and public authorities: Public authorities and a group of companies or industry bodies jointly develop these voluntary agreements. They usually involve the sharing of management responsibilities such as monitoring and evaluation. The agreement generally consists of specific targets to be met by the industry within a specified timeframe. The level of enforcement can vary from non-binding voluntary agreements to contractual agreements which contain specific control measures and might even involve sanctions (e.g. the explicit threat of regulations through public authorities).
- Voluntary agreement schemes set up by public authorities: Public authorities can develop voluntary codes, guidelines and standards in which individual firms are encouraged to participate. Participation, however, is at the discretion of individual companies.

Figure 74 shows the cause-impact relationships, indicators, and success/failure factors for voluntary agreements.

Figure 74: Voluntary agreements: Cause-impact relationships, indicators, success/failure factors

Cause-impact relationship	Indicators	Success/fail factors
Negotiation of voluntary agreement ↓		
Provision of information, training and technical services ↓	*Information and training activities* Intensity of marketing campaign Information material available Training activities offered Level of attendance	– Sufficient data / knowledge available to decide on appropriate instrument / requirements – Stakeholders consulted during the definition of instrument / requirements. – Instrument / requirements coherent with other policy measures. – Appropriate requirements (e.g. not too stringent/weak; reflecting current technology progress. – Target group prepared / skilled to implement instrument / requirements. – Costs and benefits equally distributed.
Firms, groups of firms, sectors become aware of water efficiency and scheme ↓	*Level of knowledge and awareness* Number of firms / % of sector joining aware of water efficiency / scheme	
Firms, groups of firms, sectors join voluntary scheme ↓	*Level of adoption* Number of firms joining/ % of sector joining	
Firms, groups of firms, sector adopt water efficient procedures / change services / production ↓	*Change of behaviour* Activities taken up to achieve targets.	
Reduced water consumption	*Water savings* Net impacts (based on target achievements)	

Broadly speaking, voluntary initiatives aim to increase the attractiveness of investments in water efficiency and can encourage changes in attitudes towards water efficiency, especially in sectors which previously had little interest in the issue. At the same time, a lack of interest might be one of the key barriers to the success of voluntary programmes, which can be countered by providing incentives for participation. Public authorities can encourage companies to take their own voluntary actions by presenting voluntary agreements as incentives for avoiding the introduction of tougher and more costly legislation. Frequently, participation in voluntary agreements is promoted by economic incentives or public recognitions, such as awards, labels or certificates as well as technical assistance and information services provided through the programme (*Vreuls, 2005; GTZ et al., 2006)*. One of the key success factors is the development of a baseline to which performance can be compared. This will help identify a meaningful and feasible level of improvement in the agreement. Moreover, it is important to set clear, quantifiable targets, monitoring and reporting procedures. If appropriate, sanctions against non-compliance can be introduced *(GTZ et al., 2006).*

As indicated above, voluntary agreements are commonly initiated by public authorities who often agree, sometimes implicitly, to refrain from implementing additional environmental regulations that may lead to increased costs and risks over the period of the agreement. In cases where voluntary programmes are established by firms or a group of firms, this action results from an attempt to pre-empt any regulatory initiatives. Technical assistance and information services are often provided through the programme to reduce information search and learning costs associated with implementing efficiency measures. Over the duration of the programme, new technical and management capabilities may be built up within the participating companies. Eventually, a change in products, practices or services might contribute to water savings. Outcome and impact indicators for voluntary agreements will focus on:

- Changes in awareness level.
- Changes in knowledge levels.
- Changes in adoption practice levels.
- Changes in water consumption of products, practices and services.

5.4. ANALYSIS OF EXISTING INSTRUMENTS - GAPS AND INCONSISTENCIES

➢ **Coverage of WuPs**

Table 76 shows that toilets receive the most focus in the schemes identified. This is understandable given the fact that they are one of the most water consuming products within households. On the other hand, water efficiency of washing machines and dishwashers is in general less addressed, probably because they are also EuPs. In fact, as they fall into the scope of the Ecodesign Directive, their water and energy efficiency are dealt with together at the EU level.

Garden irrigation equipments receive the least focus. Unlike key fixtures like toilets and taps, they are not found in every building. Moreover the function of irrigation WuPs itself (providing water to plants) makes it difficult to set consumption requirements. The Australian Scheme mainly deals with irrigation controllers and sensors and when it comes to the application equipments (e.g. sprinklers, drippers, etc.) it evokes manufacturing quality and functional characteristics like uniformity of application. With regards to product coverage, the Australian WELS appears to cover all key WuPs identified in the previous chapters.

➢ **Geographical coverage**

Not surprisingly, most of the schemes have been identified in countries concerned by water shortage and drought problems (Italy, Spain, Portugal, and Australia).

Within the EU, there appears to be no scheme equivalent to WELS. Most of the mandatory schemes either have a local coverage (Spanish and Italian schemes), only target toilets (United Kingdom and Ireland Building Regulations), or principally target energy consumption and not water consumption of products in particular (the Ecodesign Directive).

- **The lack of schemes targeting products in other sectors than buildings**

No schemes or programs based on a product approach and specifically dealing with water efficiency were identified for the industry and agricultural sectors. Some programs promoting water saving in industrial settings exists. For instance, in France the local authorities in charge of water (Agences de l'Eau) financially support industries which develop water saving and management plans. However, due to the diversity of products used in industrial settings, there are no specific requirements regarding the latter. As for agricultural products, the difficulties and limits of the product approach have already been discussed.

Table 76 : Summary of geographical and product coverage of the schemes identified

Name of the scheme	Geographical coverage	Mandatory/Voluntary	Products covered							
			Indoor WuP						Outdoor WuP	
			Toilets	Washing machine	Dish washer	Shower heads	Taps	Urinals	Car Wash	Garden irrigation equipment
Within EU										
Ordenanza de Gestión y Uso Eficiente del Agua (Spain)	Municipal	M	X			X	X		X	
The EU Eco-Label	EU	V		X	X					
Ecodesign Directive (inc. possible ext. to energy-related products)	EU	M		X	X	X	X			
Distintivo de Garantía de Calidad Ambiental Catalán (Spain)	Regional	V	X			X	X			
Ambientale al Regolamento Edilizio della Città di Avigliana (Italy)	Municipal	M	X			X	X			
Variante all' Art. 8 delle Norme Tecniche di Attuazione del P.R.G (Italy)	Municipal	M	X							
Regolamento Energetico Ambientale (Italy)	Provincial	M	X			X	X			
Certificação da Eficiência Hídrica de Produtos (Portugal)	National	V	X	X	X	X	X			
Water Supply (Water Fittings) Regulations (United Kingdom)	National	M	X							
BMA Water Efficiency Labelling Scheme (United Kingdom)	National	V	X			X	X			
The Blue Angel (Germany)	National	V	X					X		
The Nordic eco-label	Transnational	V		X	X				X	

Name of the scheme	Geographical coverage	Mandatory/Voluntary	Products covered							
			Indoor WuP						Outdoor WuP	
			Toilets	Washing machine	Dish washer	Shower heads	Taps	Urinals	Car Wash	Garden irrigation equipment
Outside EU										
Australia WELS	National	M	X	X	X	X	X	X		
New Zealand WELS	National	M		X	X	X	X			
USA Energy Policy Act	National	M	X	X	X	X	X	X		
Singapore WELS	National	M	X	X		X	X	X		
SmartApproved Water Mark (Australia)	National	V							X	X
Car Wash Rating Scheme (Australia)	National	V							X	
Hong Kong WELS	Regional	V				X				
WaterSense (USA)	National	V	X			X	X	X		
US Energy Star	National	V		X	X					
Singapore Green Label	National	V		X						
Korea Green Label	National	V	X			X	X			
Thailand Green Label	National	V	X	X		X		X		
Japan EcoMark	National	V	X				X	X		

5.5. OUTCOMES AND IMPACTS OF IDENTIFIED MEASURES

5.5.1. MANDATORY MEASURES – OUTCOMES, IMPACTS, BARRIERS

Mandatory instruments covered in this analysis include regulatory and information measures. The following sub-sections analyse the outcomes, impacts as well as success factors of each type of instrument.

5.5.1.1 Regulatory approaches

Few countries have to date opted for regulatory approaches to increase the efficiency of WuPs. It should be noted that whilst many of the existing labelling and certification schemes (described in sub-sections 4.4. pg. 156 and 4.5. pg.168) have established corresponding performance and test standards against which the efficiency of certain products is measured, they do not necessarily postulate a minimum level of efficiency. To our knowledge, the USA is one of the few countries where minimum water efficiency standards for residential and commercial water-using fixtures and appliances have been established through the US National Energy Policy Act (1992, amended in 2005).

- **EU Ecodesign Directive**

Outcomes and impacts

As has already been noted, the Ecodesign Directive currently covers washing machines and dishwashers, and the proposed extension of the Ecodesign Directive to include energy-related products would include additional WuPs such as shower heads and taps which consume energy through the use of hot water. However, it should be noted that concrete and detailed outcomes on this Directive in terms of reducing water consumption are not readily available as the proposal to extend ecodesign requirements to energy-related products has just been recently adopted by the EU Parliament (April 2009).

The Ecodesign Directive would permit the setting of mandatory minimum product requirements for market access, followed by specific regulations or implementing measures on specific product categories. For each category, ecodesign measures could be defined on the basis of best performers in the market place. Criteria would be reviewed periodically with a review period of 2 to 4 years to account for innovation and evolution of the market. There is a proposed link (via common product categories, datasets and assessment methodologies) with the other pillars of the SCP Action Plan such as Ecolabels and Energy Labelling.

Success and failure factors

As the ecodesign requirements for the specified WuPs have just been recently adopted, it is difficult to determine the success and failure factors. However, the recently available draft impact assessment of the Ecodesign Directive to extend it for energy-related products lists several success and failure factors to be expected should the proposal be adopted (*EC, 2008 b*):

- The main benefits of ecodesign for water using products would be a reduction in total water use, which has been estimated at 5.2% (disregarding washing and laundry machines, which are already regulated under the Ecodesign Directive and assuming that 24% of all water is consumed by the domestic sector). Moreover, less hot water used by a shower also implies that less energy is needed to heat it, which would save 0.20-0.23% of total final energy consumption in the EU-25, corresponding to 18.2 - 21.7 Mt CO_2 emissions saved per year. Reducing water use would also lead to the reduction of environmental impacts of water supply. This reduction potential would be reaped at a rate of 3% a year, at low or no extra costs.
- The current scope of the Ecodesign Directive is very limited because only the water use of washing machines and dishwashers can be regulated. For example, installing water efficient appliances for energy using products

only has the potential to reduce the water use of a household by 12 l/day, representing total savings of 4% of household water use. On the other hand, with an extended scope one can go beyond 4% reduction with existing technologies at lower additional cost.

- While the purchase prices of these products might rise in the short term, their superior performance more than offsets this over the life span of the product by lower usage costs.

US National Energy Policy Act

Outcomes and impacts

Unfortunately, little information is available on changes in production, purchasing and consumption patterns following the introduction of the Energy Policy Act. However, some general conclusions can be drawn based on initial estimations of potential water savings.

- The standards apply to nearly all toilets, urinals, showerheads, and faucets manufactured after January 1994 (efficiency standards for other fittings and appliances were subsequently phased in the following years). Based on the combination of fixtures and different ages in use at the time of the passage of the Act, it was projected that the water consumption of the average 2.63-person household of about 550 l/day would drop to about 250 l/day by 2026 (*Vickers, 1993*). However, it should be noted that these projections presume that all pre-1994 fixtures have been replaced by a new generation of more efficient fixtures and appliances. Furthermore, given that these calculations stem from the year 1993, many of the assumptions on which these projections are based might have changed since then.
- Shortly after the passing of the Energy Policy Act, experts assumed that a transition towards more efficient fixtures and appliances would affect utility revenues and customers' water bills. Water savings were expected to result in somewhat lower water bills, thereby also reducing system revenues. These reductions in revenues in turn were expected to necessitate rate increases to recover system costs. Therefore, customers who installed efficient fixtures or chose to take other conservation measures were not expected to have higher bills, because even though the cost of water might increase, their use would decrease enough to compensate for the difference (*Vickers, 1993*).

Success and failure factors

Similarly, little insight is available into possible success factors and barriers encountered during the drafting and implementation of this bill. However, the Energy Policy Act features several characteristics which are frequently associated with successful policy designs and implementation: the Act established a coherent policy-mix with standards, information instruments and economic incentives and economic impacts are assumed to be equally distributed.

5.5.2. Labels

The review of existing water efficiency policy measures identified three very similar mandatory labelling schemes which will be analysed in more detail:

1. The Australian WELS
2. The New Zealand WELS
3. The Singaporean WELS Singapore

- **WELS Australia**

Outcomes and impacts

- Since the WELS came into effect, over 8 000 registrations have been made. The actual number of registered products is significantly greater than this, however, since manufacturers may register a 'family of products' and only pay a single registration fee.
- A recent survey has shown that 59% of consumers and 66% of non-consumers indicate unprompted awareness of water efficiency labelling. When prompted, (with a label on screen), consumer awareness dropped marginally to 53% and to 73% amongst non-consumers *(Quantum, 2008).*
- It is estimated that by the year 2021, the total accumulated water savings would be about 610 000 million litres of water when compared to the business as usual scenario *(Wilkenfeld, 2008).* The amount of water actually saved through the implementation of the WELS up until now could not be established.
- With regards to economic impacts, an impact assessment carried out in 2008 *(Wilkenfeld, 2008)* found that WELS would not lead to any changes in the size of the water using fittings and appliances market. Impacts on small business were predicted to be minimal, with most impacts projected for medium sized enterprises.
- Over the period 2003 to 2021, it was projected that domestic consumers would spend about 2.5% more on the purchase of WuPs, compared with the business as usual case: about 10.1% more on showers, 7.6% more on taps, 4.4% more on clothes washers, 1.3% more on dishwashers, and 0.5% more on toilets. However, at the same time, it was estimated that consumers would save around $400 million, mainly due to reduced water and energy bills *(Wilkenfeld, 2008).*

Success and failure factors

A number of factors seem to have contributed to the increasing success of the WELS:

- Whilst the first few years saw a focus on education and advice, the government is now moving towards stronger enforcement action. Between July 2007 and 2008, 97 cases of potential non-compliance were investigated and an increasing number of inspectors has been qualified and appointed. The WELS Act not only specifies fees but also penalties: $1 320 for individuals and $6 600 per company offence.
- The WELS Act and standards are continuously being reviewed in order to clarify requirements, correct inconsistencies and omissions, and improve the effectiveness of the initiative.
- Four and five star WELS labelled products are commonly linked to cash rebates and other incentives operated by water utilities or local governments, promotional campaigns, giveaways, etc., which highlights the positive interactions between different policy measures but also raises the question of whether the label on its own might be influential enough to change consumer behaviour.

Despite these positive factors, a number of challenges are reported in the literature (*MTP, 2008*):

- Critics of the WELS label point out that bureaucracy burdens the operation of the scheme and that an active government and parliament, not the market, drive it.
- There is a lack of involvement of stakeholders as well as communication and marketing to the consumer.

➢ New Zealand WELS

Outcomes and impacts

Given that the New Zealand WELS is not operational yet, potential impacts can only be estimated (*MTP, 2008*):

- In 2004, a cost-benefit analysis of a WELS for New Zealand concluded that the implementation of a label for New Zealand could produce small net benefits if the label was successful in bringing about water efficiency improvements in products.
- By the year 2020, water savings of approximately 859 million litres compared to the business as usual scenario are forecast, with the highest savings projected for washing machines and showers.
- The analysis also estimated that a labelling scheme would increase the cost of WuPs by about NZ$1.00 per item sold.

Success and failure factors

No information.

➢ **Singapore WELS**

The Singapore WELS was introduced in 2006 as a voluntary label to help consumers make informed purchasing choices and to encourage manufacturers to develop more efficient products. Since it will become mandatory to label taps, dual flush low capacity flushing cisterns, and urinals and urinal flush valves only in July 2009, its effects will be discussed under next sub-section.

5.5.3. VOLUNTARY MEASURES – OUTCOMES, IMPACTS, AND BARRIERS

Voluntary instruments covered in this analysis include voluntary agreements and information measures. The following sub-sections analyse the outcomes, impacts as well as success factors of each type of instrument.

5.5.3.1 Voluntary agreements

The review of existing water policy measures has identified the following two voluntary agreements which will be analysed in more detail in this sub-section:

1. The US-American SWAT Programme , and
2. The Australian Waterwise Irrigator Programme (WGIP).

➢ **SWAT USA**

- **Outcomes and impacts**

- The Irrigation Association lists 19 water products (controllers) which meet the programmes requirements and 44 programme partners.
- Many water providers now require SWAT test results as a prerequisite for their rebate and incentive programs.
- No data could be found on actual water savings achieved through implementation of the scheme so far. However, smart controllers are estimated to save nearly 24 billion gallons of water (approximately 528 million litres) per year across the USA (*Irrigation Association, 2008*).

- **Success and failure factors**

No information available.

➢ **WGIP Australia**

- **Outcomes and impacts**

- In its first iteration from 2003 to 2005, the WGIP had 73 individual members and 30 business members. Since its re-launch in 2007, 120 individual members and 54 businesses have (re-)joined the initiative (Hall 2008).
- Information on water savings achieved through the programme could not be found.

Success and failure factors

The original format of the program demanded that members submit quarterly audit return forms with details of all systems installed under the program. A small sample of these jobs was then audited. Unfortunately this process proved difficult to manage as a number of members failed to submit these forms on a regular basis or in a timely manner. Furthermore, upon examination, many systems actually failed to meet the standard required to be called 'Waterwise'. Following these early experiences the revised initiative included the following changes (*Hall, 2008*):

- More frequent and independent audits of installed irrigation systems are carried out to ensure compliance with the design principles of the program and the technical specification.
- Sanctions were introduced to ensure that where any member fails to install systems to the required standard, installers would be compelled to correct their mistakes and avoid similar problems in the future. Moreover, consistent failure to meet the appropriate standard results in suspension or expulsion from the programme.
- A rebate system was initiated amounting to up to $300 and since 2008 to $400. As part of the rebate program resources will be made available to ensure that a minimum of 1 in 10 systems installed by each member installer will be audited.

5.5.3.2 Labels

Labels are among the most frequently employed water efficiency measures currently found inside and outside Europe. To reiterate, in this study the term 'label' refers to product information schemes using a rating or ranking system. In contrast, certificates are awarded to products achieving a certain benchmark (analysed in sub-section 5.5.3.3 pg. 216). The analysis in this sub-section focuses on the following labelling initiatives:

1. The Portugese Certificacao de Eficiencia Hidrica de Produtos (ANQUIP Label).
2. The Irish Water Conservation Label.
3. The Australian 5-A Scheme.
4. The Singaporean WELS.

Due to a lack of available data and a fairly recent establishment respectively, some of the labels presented in chapter 4 were not included in this analysis. Moreover, the German Sustainable Building Label and the National Australian Built Environment Rating System which also fall into this instrument sub-category will be analysed in more detail in the related study on water performance in buildings.

ANQIP label

Outcomes and impacts

Given that this labelling scheme has only been introduced fairly recently, little information is available on its progress and uptake. According to ANQUP, 60% of the market which is currently participating in the initiative has adhered to the scheme *(Rodrigues, personal communication).*

- **Success and failure factors**

Similarly, little is known about the limiting or facilitating factors influencing the success of the scheme. However, ANQIP has noted that raising public awareness of water efficiency issues and the scheme is the one of the key challenges facing the initiative *(Rodrigues, personal communication).*

- **Water Conservation Label, Ireland**

- **Outcomes and impacts**

Only a few retailers participated in the programme and the scheme seems to have been disbanded.

- **Success and failure factors**

There is little information available as to why the initiative was discontinued. The literature reports that the City of Dublin Energy Management Agency operating the scheme found that since the programme was voluntary there was little interest from retailers to display the label. Retailers seemed to consider the labelling of wet white goods as too much work and that this information was not in demand by customers *(MTP, 2008)*.

- **5-A Scheme, Australia**

- **Outcomes and impacts**

It is generally accepted that the scheme achieved only limited success (*MTP, 2008*):

- Few suppliers participated in the scheme and only a selection of the very best products achieved a rating. There is no data on the market share of labelled products, only for washing machines and dishwashers as the energy label was mandatory for these appliances. Figures show that only 6% of dishwashers were labelled under the 5A scheme, and about 20% of washing machines.
- No survey into consumer awareness of the scheme has been carried out but it is reported that public knowledge of the initiative was generally low

- **Success and failure factors**

A recent study highlights the following factors which hindered the success of the 5-A Scheme (*MTP, 2008*):

- There was a lack of information and publicity since only the water utilities were responsible for marketing to the public.

- Consumers tended to assume that products labelled with a good water efficiency rating also performed well. Under the 5A Scheme performance was misleading since products were not rated according to performance in a real environment, e.g. the label did not indicate that an AAA-rated shower might not work under low pressure.
- The primary incentive for manufacturers to label their models was to gain the support of water utilities, which publicised the scheme and labelled products, often linking them to cash rebates and other incentives. Some manufacturers seemed to participate in the scheme to promote a positive brand image in a time of severe drought.

➢ ***Singapore WELS***

Outcomes and impacts

At launch in October 2006, fifteen brands were already participating in the labelling programme. As of the end of December 2007, 561 products have received the label, representing 52 brands (*MTP, 2008*).

Success and failure factors

No information.

5.5.3.3 Certificates

As explained earlier, certificates are product markings indicating whether a fitting or appliance complies with one specified efficiency level rather than differentiating various levels of efficiency (as labels do). Readers should be aware of this difference but also need to note that whilst initiatives analysed in this sub-section might be called label, certificate, mark etc., they are all benchmark or endorsement certificates. The following certificates will be examined in more detail in this sub-section:

1. the United Kingdom BMA Label
2. The USA-American Water Sense Mark
3. The Australian Smart Approved Water Mark
4. The European Eco-Label
5. The Blue Angel (Germany)
6. The Energy Star (USA)
7. The Nordic Swan (Denmark, Sweden, Norway, Finland, and Iceland)
8. The Catalonian Environmental Quality Guarantee label (Spain)

It should be noted that not all the certificates presented in the inventory in chapter 4 could be analysed in more depth due to a lack of appropriate information. The schemes analysed here can be classed into two broad groups: water-specific (numbers 1-3) and multiple issue certificates (numbers 4-8).

The United Kingdom BMA Label

Outcomes and impacts

- 530 products listed across 5 categories by 18 well known brands in the United Kingdom market many of which are international brands (May 2009).
- The scheme does not collate any statistical data so it cannot be estimated how much water has been saved since it was launched but manufacturers have seen a growth in water efficient products *(Yvonne Orgill, personal communication).*

Success and failure factors

According to a representative of the BMA, the implementation of the labelling scheme is met by a number of challenges *(Yvonne Orgill, personal communication):*

- Since the launch of the scheme, market conditions have seen a downturn which has hampered the sale of such equipment within new build and refurbishment.
- The scheme is voluntary and requires an additional market push from interested parties and governmental bodies, for example through endorsement of the label or tax reductions.

The US-American Water Sense Mark

Outcomes and impacts

- The WaterSense Mark is now found on more than 170 different toilet models and 100 faucets or faucet accessory models that are independently tested and certified to meet EPA's criteria for both efficiency and performance *(EPA,2009).*
- Although periodic evaluations are foreseen, information on impacts on water consumption, market share of labelled products or changes in consumer awareness is currently not available.

Success and failure factors

To date, little information is available to judge the success of the scheme or to gain insight into factors driving or hindering its progress. However, a number of programme features have been identified which are assumed to be beneficial for its progress (*MTP, 2008*):

- The EPA launched the WaterSense after two years of intense stakeholder discussions and programme development.

- There is also a heavy focus on public education and outreach as part of the overall WaterSense strategy, e.g. through their website which lists labelled products and services.
- There are no fees associated with partnership, labelling, or listing of a product as part of the WaterSense programme; however, all fees associated with third party testing must be met by the manufacturer.
- Partners are eligible for the annual WaterSense Awards that recognise a Promotional Partner of the Year, Manufacturer Partner of the Year, Retailer/Wholesaler/Distributor Partner of the Year, and Irrigation Partner of the Year.
- Utilities have found the programme particularly beneficial because it sets out federally recognised definitions for water efficient programmes, which then make it easier for water utilities to link WaterSense products to cash rebates and other incentive schemes.
- As the programme advances, the EPA will regularly assess progress and impact. Data on programme activity (e.g. number of partners, labelled products, etc.) are collected internally, and the EPA also collects product and sales data from WaterSense partners. The EPA has also committed to surveying audience groups in order to monitor awareness and understanding of the label.
- The WaterSense programme is funded through the EPA's core budget, from which about US$2,300,000 is allotted annually for the programme. The programme is overseen by six permanent, fulltime staff members within the EPA.
- Comparative studies for toilets have shown that there is no price difference between WaterSense labelled products and standard products.
- One factor which proved to be a challenge early on in the programme was the bad press surrounding high efficiency low flush toilets. Media reports claimed that they did not perform well which led to caution during the development of WaterSense, but overall stakeholder, media, and consumers now seem to be reacting positively to the WaterSense programme.

➢ ***The Australian Smart Approved WaterMark***

Outcomes and impacts

The Watermark is widely viewed as a successful scheme; although detailed evidence is limited and anecdotal. The MTP report (2008) states that:

- Consumer recognition of the WaterMark is currently about 30%.
- Over 130 products and services are currently labelled with the WaterMark.

Success and failure factors

- The WaterMark was re-launched in 2006 after government funding allowed the brand to be marketed more prominently; previously the label had little exposure. Funding for the WaterMark for the period 2006 – 2009 totals AU$1.88 million: $1.18 million from the Australian Government, $80,000 from the WSAA and partners, and $620,000 from license and application fees.

- The programme dedicates one website to raising awareness among potential participants of the programme and one, to inform the consumer of the WaterMark. Here, details of approved products and services are listed, and it also hosts a water rebates page that provides consumers with information on where they can go to get money off water saving products.

The European Eco-label

Outcomes and impacts

Labelling specifications for washing machines and dishwashers came into force in 2000 and 2001 respectively (although requirements for both products are currently expired). A study into the benefits of the Eco-label (*AEAT, 2004*) estimated the following potential water savings:

- For washing machines, savings were forecast to be approximately 396 312 300 litres per year (5% uptake), 1 585 249 200 litres per year (20% uptake) and 3 963 122,900 litres per year (50% uptake) respectively.
- For dishwashers, savings were forecast to be approximately 20 185 400 litres per year (5% uptake), 80 741 800 litres per year (20% uptake) and 201 854 400 litres per year (50% uptake) respectively.

These projections were based on sales data for these product groups from the year 1998. However, no washing machine has ever been awarded the ecolabel and only one dishwasher has received this quality mark until now. Washing machines are no longer among the list of products considered by the EU Eco-label.

The recent impact assessment on the proposed revision of the Eco-label states that by revising the current Eco-label scheme, it will lead on the one hand to a considerable increase in companies using the label, and so also to an increase in Ecolabelled products on the market and, on the other hand, to an increase in the number of consumers that know about, and are prepared to buy, Ecolabelled products as well as to an increase in the use of EU Ecolabel criteria in public procurement (*EC, 2008 a*). The impact assessment concludes that, as a voluntary instrument, a modified Ecolabel can have net economic benefits for the EU economy, and increase both competition and competitiveness. The Ecolabel therefore works with the market and – with its simplified approach – is a model "better regulation" policy instrument.

Success and failure factors

The recently available draft impact assessment of the Ecolabel Revision *(EC, 2008 a)* and other studies give insight into the factors that facilitated and hindered the success of the Eco-label scheme (*Karl and Orwat, 1999)*:

- Insufficient product group categories
- Procedural and organisational problems –i.e. bureaucracy
- There were no further incentives for environmental innovations once manufacturers have passed the environmental criterion hurdle.
- There are obstacles of defining uniform environmental criteria for the whole European Community because the regulation ignores different.
- Low awareness: low awareness is seen as the most significant barrier in using the Ecolabel for marketing purposes. According to a recent survey, 48% of Europeans do not know what the logo means while only 11% correctly said that it is a label for ecological products and services *(EC, 2008 a).*
- Low uptake by industry: the EU Ecolabel still commands a very small EU market share in relative terms.

Some of the success factors include:

- Cooperation and coordination with other policy instruments will determine the Eco-label's success in terms of the economic and environmental impacts of the scheme.
- A more successful Eco-label will depend on a substantially increased marketing budget.

Blue Angel (Germany)

Outcomes and impacts

- By the beginning of the year 2000, the requirements for approximately 100 product categories had been defined, though some are no longer in use because either their objectives were achieved, they had been replaced by binding standards, or they were cancelled for other reasons.
- Manufacturers have signed contracts for the use of the Blue Angel in approximately 4000 products (2002). Currently, 27 WuPs are labelled under this scheme (May 2009).

Success and failure factors

The Blue Angel is widely considered a success, which Müller (2002) attributes to the following factors:

- Individual manufacturers, domestic and foreign, seized the opportunity to increase their market share.
- Opinion polls during the 1970´s and 1980´s indicated a high degree of environmental awareness in the German population. As early as the 1980s, surveys found that the Blue Angel was known by approximately 80% of

German citizens. In the 1990s, 60 to 78% of the interviewees indicated that they would prefer Blue Angel products to non-labelled goods if they saw them on shop shelves.

- Frequent media reports helped make the Blue Angel known to the general public at a time when products marked with the Blue Angel could hardly be seen on shop shelves.
- The program is embedded in a solid institutional set-up and receives strong political support. Throughout its history, the Blue Angel has enjoyed the continuous support of the staff of the Federal Environmental Agency

At the same time, the authors note the following difficulties faced by the programme:

- The lack of public resources, human as well as financial, for the preparatory and public relations work also led at times to frustrations on the side of innovative manufacturers.
- The coordination unit of the Federal Environmental Agency was responsible for the entire management of the Blue Angel program. The work was done by two officials who were also in charge of other general coordination tasks.

➢ ***Energy Star (USA)***

Outcomes and impacts

The Energy Star programme publishes annual reports which give an indication of its success. Water efficiency relevant impacts, however, cannot be delineated from these publications. In the 2007 report, the following achievements were highlighted (EPA 2008):

- By 2007, more than 40 000 products had qualified for the Energy star. By comparison, in the year 2000 it had been around 11 000.
- More than 2.5 billion labelled products have been sold over the total duration of the programme
- Public Awareness of the Energy Star has increased from 40% in 2000 to over 70% in 2007
- More than 2,000 manufacturing partners and 1 000 retail partners have so far joined the scheme.

Success and failure factors

No information.

➢ ***Nordic Swan (Denmark, Sweden, Norway, Finland, and Iceland)***

Outcomes and impacts

In May 2009, approximately ten car washes, seven laundries, ten washing machines (by two companies) and ten dishwashers (by two companies) had been labelled under the scheme.

Success and failure factors

According to Reinhard et al. (2001), the success of the Nordic Swan has been hampered by the following factors:

- The negative attitude towards eco-labelling often found among producers has significantly limited the market penetration of the Swan label in all of the Nordic countries.
- Other factors that have influenced the selection of product groups, criteria and market acceptance include the existing differences in the environmental, technological, market and cultural characteristics of the Nordic countries. These differences will sometimes create obstacles to setting strict criteria that are relevant to the situation in all the Nordic countries, thereby imposing further limitations on the potential of the Swan label.

The Catalonian Environmental Quality Guarantee label

Outcomes and impacts

17 manufacturers have joined the label with a total of approximately 794 certified products. The total market share is still limited, although increasing progressively. The label has also been widely accepted by the regional administrations (green public procurement).

Success and fail factors

The level of label recognition is still relatively low among consumers. Existing national and international norms are less restrictive than the ones formulated by the scheme, therefore providing little incentive for manufacturers to adhere to the strict label requirements.

Table 77 provides a summary overview of the analysis presented above.

Table 77 : Summary of outcomes, impacts and barriers of investigated instruments

<table>
<tr><th colspan="3">Policy</th><th>Year</th><th>Outcomes</th><th>Impacts</th><th>Success factors</th><th>Failure factors</th></tr>
<tr><td rowspan="5">Mandatory measures</td><td>MPS/ TS</td><td>National Energy Policy Act (USA)</td><td>1992/ 2005</td><td>No information.</td><td>Projected: water consumption of the average 2.63-person household of about 550 l/day to drop to about 250 l/day by 2026.</td><td>Policy mix; supported my economic measures.</td><td>No information</td></tr>
<tr><td colspan="7">Information</td></tr>
<tr><td rowspan="3">Label (L)</td><td>Australian WELS</td><td>2005</td><td>> 8 000 products registered;
> 50% public awareness of label</td><td>Projected: by year 2021, total accumulated water savings about 610 000 million litres when compared to business as usual scenario</td><td>Education and information; continuous reviews and updates; penalty fees; supporting economic measures.</td><td>Bureaucracy; lack of stakeholder involvement</td></tr>
<tr><td>New Zealand WELS</td><td>2009</td><td>No information</td><td>Projected: by year 2020, total accumulated water savings about 859 million litres when compared to business as usual scenario</td><td>No information</td><td>No information</td></tr>
<tr><td>Singapore WELS</td><td>2006/ 2008</td><td>At launch in October 2006, fifteen brands were already participating in the labelling programme. As of end December 2007, 561 products have received the label, representing 52 brands</td><td>No information</td><td>No information</td><td>No information</td></tr>
</table>

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
Voluntary measures	**Voluntary agreements**						
	Industry only	Smart Water Application Technologies (USA)	2002	19 water products registered; 44 programme partners	Projected: smart controllers are estimated to save nearly 24 billion gallons of water per year.	No information.	No information.
	Government only	Waterwise Garden Irrigator Programme (Australia)	2004	2003 to 2005: 73 individual members and 30 business members. Since its re-launch 2007, 120 individual members and 54 businesses have (re-)joined the initiative.	No information	Frequent audits; penalty fees and sanctions; supporting economic measures.	No information.
	Information						
	Label (L)	ANQIP Label (Portugal)	2008	60% of the market are currently participating in the initiative has adhered to the scheme	No information	No information	Lack of public awareness
		Water Conservation Label (Ireland)	2003	Only a few retailers participated in the programme and the scheme seems to have been disbanded	No information		Lack of interest and incentives

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		Car Wash Water Saver Rating Scheme (Australia)	2004	No information	No information	No information	No information
		5-A Scheme (Australia)	1988-2005	Few suppliers participated in the scheme; only 6% of dishwashers were labelled under the 5A scheme, and about 20% of washing machines.	No information	Economic incentives	Lack of information and awareness
	Certificate (C)	BMA label (United Kingdom)	2007	530 products listed across 5 categories by 18 well known brands in the UK market many of which are international brands.	No information		Economic down-turn, lack of additional market push from interested parties and governmental bodies, for example through endorsement of the label or tax reductions.

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		Water Sense (USA)	2006	> 170 different toilet models and 100 faucet or faucet accessory models.	No information	Stakeholder consultation prior to establishment of initiative, education and information, no fees, supporting economic measures	No information
		Smart Approved Water Mark (Australia)	2004/ 2006	>130 products labelled, consumer recognition at 30%	No information	Sufficient funding, information and education	No information
		European Eco-label	1993	1 dishwasher; no washing machine was ever awarded the Eco-label; they no longer qualify for the labelling scheme	Projected for washing machines; savings forecast to be approximately 396 312 300 litres per year (5% uptake), 1 585 249 200 litres per year (20% uptake) and 3 963 122 900 litres per year (50% uptake) respectively. for dishwashers, savings forecast to be approximately 20 185 400 litres per year (5% uptake), 80 741 800 litres per year (20% uptake) and 201 854 400 litres per year (50% uptake) respectively.	No information	No supporting measures, e.g. economic incentives; difficult to define uniform criteria for whole Europe because of different production technologies, environmental practices, levels of consumer awareness.

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		Blue Angel (Germany)	1978	By 2000 requirements for approximately 100 product categories had been defined, approximately 4,000 products, labelled, currently, 27 WuPs are labelled under this scheme, in the 1990s, from 60 to 78% of the interviewees indicated preference for Blue Angel products	No information	Interest by individual manufacturers, high environmental awareness, positive media reports, good institutional set-up and support, high level of credibility of certifying institution	The lack of human resources of coordinating institution.

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		The Catalonian Environmental Quality Guarantee label	1994	17 manufacturers have joined the label with a total of approximately 794 referenced products, market share is still limited, although increasing progressively, label has also been widely accepted by the regional administrations, (green public procurement).	No information	No information	Lack of recognition among consumers, existing national and international norms are less restrictive than the ones required by scheme

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		Energy Star (USA)	1992	By 2007, more than 40 000 products had qualified for the Energy star; in comparison, in the year 2000 it had been around 11 000 > 2.5 billion labelled products have been sold over the total duration of the programme, public awareness of the Energy Star has increased from 40% in 2000 to over 70% in 2007, > 2 000 manufacturing partners and 1,000 retail partners have so far joined the scheme.	No information	No information	No information

Policy			Year	Outcomes	Impacts	Success factors	Failure factors
		Nordic Swan (Scandinavia, Finland, and Iceland)	1989	In May 2009 approximately 150 hotels, 24 restaurants, ten car washes, seven laundries, ten clothes (by two companies) and ten dishwashers (by two companies) had been labelled under the scheme.	No information	No information	Negative attitudes towards labelling among retailers, differences in the environmental, technological, market and cultural characteristics of the participating countries.

5.6. BEST PRACTICES

5.6.1. ANALYSIS OF BEST PRACTICE CASE STUDIES

Chapter 4 revealed several schemes at both the MS and international level that are further examined in more detail in this sub-section because they serve as good examples of existing schemes. They have been proven effective, whether in terms of raising consumer awareness or accomplishing actual water-savings. The following aspects were compared and evaluated in each case in order to draw some conclusions and determine some lessons learnt:

- Motivation for inception – Reasons why scheme came into being, and what factors might have influenced its inception.
- Implementation, requirements and control measures – A description of which stakeholders are eligible for joining the scheme, the steps that lead to joining, how products are tested for compliance, and what occurs in case of non-compliance.
- Supporting legislation and auxiliary measures – A brief assessment of the influence other legislative instruments or standards may have on the scheme (e.g. CEN or ISO standards).
- Acceptance (by manufacturers, retailers and general public) – Brief assessment on how well the scheme has been accepted by different stakeholders. E.g. how many products have been certified so far.
- Additional accomplishments – Other findings such as increased market share since inception, or amount of water saved, if information is available.
- Challenges and limitations – Problems thus far faced by the implementing authority, such as lack of funding, lack of authority, lack of acceptance, etc.
- Future prospects –What changes may be made to the scheme in future. E.g. the addition of new product categories, expansion of coverage area, etc.

Five best practice cases were selected, including:

- BMA Water Efficiency Labelling Scheme (United Kingdom)
- ANQIP Certification for Product Water-use Efficiency (Portugal)
- The Catalonian Environmental Quality Guarantee label (Spain)
- Water efficiency labelling scheme (Australia)
- WaterSense (USA)

For each case study, a dedicated fact sheet with detailed information on the above mentioned elements was elaborated. These can be found in Appendix 4.

5.6.2. Lessons to be learned

The schemes that have just been analysed are good examples of existing initiatives at both the MS and international levels and several observations and important lessons can be drawn from these case studies.

The Bathroom Manufacturers' Association scheme incorporates both national and international manufacturers, which results in a wider scope and range of products covered under the scheme in the United Kingdom. As the newest scheme introduced in 2008, ANQIP was able to attract manufacturers because of its voluntary nature which reduced the risk of resistance from such manufacturers. The WaterSense Program was also able to attract a large network of partners by providing many incentives and publicity campaigns to invite services and manufacturers to join the WaterSense cause by developing water efficient products and services.

The WaterSense program demonstrates that even as a voluntary program, specifications or water performance criteria can be set to ensure that products are water efficient. EPA's first specification, released in January, 2007, was written for HETs. Specifications have since been written for bathroom sink faucets and certification programs for irrigation professionals. Draft specifications have been issued for both new homes and flushing urinals. Specifications for showerheads and irrigation control technologies are currently under development.

The Australian WELS operates in partnership with a sister scheme - the SmartWater Mark, which is voluntary and covers outdoor WuPs. It is important to link such related schemes (i.e. mandatory and voluntary schemes that cover different products) in combined branding campaigns to maximise effectiveness of campaigns to raise awareness of these programs. In the example of WELS, prioritisation of products and corresponding actions for each product or service is very important. For example, for certain products such as toilets and taps, minimum efficiency levels should be implemented. For products such as washing machines and dishwashers, it would be easier to make the connection between energy and water efficiency.

The case of the Catalonian Environmental Quality Guarantee label illustrates the importance of the implication of manufacturers in all the stages of development of the label and associated requirements. An important element that has also contributed to the good acceptance of the label among manufacturers is the low application and renewal fee, the absence of annual fees and the reductions for SMEs and applicants with EMAS or ISO 14001. It does also show how important is to have in place a general water management program in which the specific water efficiency requirements to be implemented can be integrated. The lack of knowledge and awareness by users and consumers is usually one of the barriers in the case of voluntary schemes. In such cases, it is important to carry out information and awareness raisings campaigns. Furthermore, it is important to involve suppliers and retailers in the process so they can promote the products amongst consumers.

All these schemes emphasise the importance of raising consumer awareness and recognition of existing water-saving schemes in order for them to be effective. As is seen in the Australian WELS, intensive consumer awareness campaigns are important in raising consumer recognition and this overall effectiveness of the scheme. For this, attention should be focused on educating and informing the public on the advantages of the scheme and the environmental and economical benefits associated with conversing water by using labelled WuPs.

5.7. COMPARATIVE ANALYSIS OF BENEFITS AND LIMITATIONS

The aim of the analysis of existing water efficiency policy measures was to identify their benefits and limitations and to illustrate their implementation challenges. As the previous analysis has shown, it is difficult to make a comparison at an aggregate level because the sample of investigated schemes is not very balanced. Whilst many experiences exist with certification or labelling schemes, hardly any regulatory approaches could be identified. Moreover, a lack of in-depth quantitative and baseline information does not allow drawing any conclusions about the relative effectiveness of different policy measures. Therefore, we can only provide a very generic discussion of the positive and negative aspects of different types of policy measures and offer some tentative conclusions based on the literature and the experiences presented in the preceding sections of this chapter. The study limitations and suggestions for future work are discussed in more detail in chapter 7 pg. 270. The following comparative analysis is organised around five key issues: regulation vs. information instruments, voluntary vs. mandatory instruments, ranking labels vs. endorsement certificates, single issue vs. multiple issue instruments, and finally single measures vs. policy mixes.

5.7.1. REGULATION VS. INFORMATION INSTRUMENTS

The review of existing water policy measures shows that governments have to date made little use of regulatory approaches and seem to prefer information instruments, such as labels and certificates. The policy literature shows that regulatory instruments are highly effective in achieving their objectives, are relatively easy to set up and provide clear and transparent procedures for affected businesses *(e.g. GTZ et al., 2006).* The major benefit of norms and regulations, such as minimum or maximum performance standards is that (most) water savings are guaranteed, as customers will only be able to purchase efficient equipment. Furthermore, once in place, minimum standards cannot be 'lowered' again, meaning that neither manufacturers nor retailers can revert to providing consumers with appliances not meeting the specified requirements *(Boardman, 2004).* However, one of the major disadvantages, when compared to information instruments is that they fail to create environmental awareness among the public. Where data is available, labelling and certification schemes, such as the Energy Star, the German Blue Angel or the Australian WELS have shown to be recognised by a large proportion of the public, thus indicating a heightened awareness for environmental issues. Whether and how this knowledge actually influences purchasing behaviour is difficult to establish though. A drawback of information measures is the existence of many different labelling and certification schemes. In Australia, for instance, four different water-related labels are currently in use plus an energy efficiency label. Although all these schemes address different products and services, they pose the danger of leading to customer confusion. Critics further argue that labels are obsolete as long as legal requirements exist which are stringent enough to eliminate the worst offenders *(MTP, 2008)*.

5.7.2. VOLUNTARY VS. MANDATORY INSTRUMENTS

Whilst regulatory instruments are by definition mandatory, information instruments can be both mandatory and voluntary. The majority of identified labelling and certification schemes currently in operation within and outside Europe are voluntary. As the MTP study (2008) highlights, voluntary schemes require that manufacturers and suppliers have an incentive to label, e.g. the need to distinguish a new technology or highlight aspects of an existing product. As the experiences with the 5-A Scheme or the Dublin Water conservation Label show, voluntary schemes frequently struggle to motivate manufacturers to participate. In both initiatives, uptake of the scheme was low. It is often pointed out that mandatory labels and certificates provide higher incentives for manufacturers to increase the efficiency of their products, creating more competition within the market and providing more choice to the consumer. It is also important to note that voluntary labels indicate that a product is water efficient. However, unlabelled products are not necessary inefficient. This problem would not arise in the case of mandatory labels. Yet, as the case of the BMA Label as well as the investigated voluntary agreements show, strong sectoral involvement and commitment can significantly push the success of a voluntary information scheme. Furthermore, water efficiency can be promoted in sectors where little progress has been made previously.

5.7.3. RANKING VS. ENDORSEMENT

This study distinguishes between ranking labels and endorsement certificates. Ranking labels indicate the relative water efficiency of a product in comparison to other products in the same category, either through a rating (e.g. Five Stars) or by providing a standardised figure for comparison (e.g. litres per load). Certificates simply indicate that a product meets certain minimum requirements or that it is in some way preferable to similar products (*MTP, 2008*). One of the advances of certificates is certainly the reduced efforts and costs in defining elaborate requirements and test protocols; they only need to formulate a benchmark level which a product has to meet. However, the fact that only one level of efficiency exists might hamper the drive for improving product efficiency beyond this standard.

5.7.4. Single issue vs. multiple issues

Currently, labelling and certification schemes tend to address multiple environmental issues, such as the Blue Angel, Nordic Swan or Energy Star; fewer initiatives target water efficiency exclusively. Whilst a multiple issue approach certainly helps to keep programme costs down by bundling human and financial resources, it might, in the case of information instruments, lack clarity for consumers who have to rely on an aggregate measure to judge the overall environmental performance of a product. Furthermore, addressing water efficiency as one concern among many might not help promote the issue, as other environmental aspects might be prioritised by consumers. It should further be noted that not only the spectrum of environmental aspects might have certain implications for the implementation and success of a policy measure, and also the geographical scope might be of relevance. Both the European Eco-label as well as the Nordic Swan seem to struggle with differences in technological standards, environmental attitudes and cultures in the participating states, especially when it comes to defining product-specific requirements

5.7.5. Single instrument vs. policy-mixes

The experiences reported above illustrate that water policy measures are frequently part of a policy mix. Less successful initiatives like the Australian 5-A Scheme have shown that particularly voluntary instruments need to be embedded in a comprehensive policy framework which motivates target groups to take action by offering incentives, organising information and education campaigns as well as acting as role models. A good example is the German Blue Angel where governmental bodies have continuously supported and promoted the scheme through media campaigns. Their 'green' public procurement was one of the key drivers for the continued success of the label, similar to the experiences made with the Catalonian Environmental Quality Label.

Table 78 summarises the benefits and limitations of different categories of policy measures and briefly outlines the conditions for which these instruments seem most appropriate.

Table 78 : Benefits and limitations by policy measure (GTZ et al., 2006; Khan et al., 2006)

	Type of instrument	Benefits	Limitations	Relevant / appropriate for
Mandatory measures	**Regulation** Minimum Performance / Technical Standard	Eliminates low efficiency products from the market. Easy to establish. Clarity for businesses.	High costs. Low innovation incentive. Fails to create consumer awareness. Potential impacts on competitiveness and international trade.	Target group is unwilling to act or lacking interest. Least efficient products or services are to be removed from the market as quickly as possible. Target technologies are rather uniform.
	Information Label Certificate	Creates consumer awareness. Rewards leadership.	Potentially too many different labels. Potential trade effects. Requires supporting measures, e.g. economic incentives, large-scale information campaigns.	High knowledge / information barrier limits adoption of efficient products. Large consumer or service sector groups. Target technologies are rather uniform but performance varies greatly between similar products. When planning to introduce a performance standard at a later stage.
Voluntary measures	**Voluntary agreements** Industry only agreement Government – Industry agreement Government only scheme	Provides greater flexibility than regulatory instruments. Encourages proactive behaviour. Establishes dialogue and interaction between industry and government.	Difficult to initiate in sectors with little interest. Efficiency targets potentially weaker than in regulatory instruments to suit interests of target groups. Difficult to ensure global application and compliance.	Group of target actors is quite small and well organised. High savings can be achieved relatively cheap.
	Information Label Certificate	Creates consumer awareness. Rewards leadership.	Potentially too many different labels. Potential trade effects. Requires supporting measures, e.g. economic incentives, large-scale information campaigns.	High knowledge / information barrier limits adoption of efficient products. Large consumer or service sector groups. Target technologies are rather uniform but performance varies greatly between similar products. When planning to introduce a performance standard at a later stage.

5.8. CHAPTER KEY ELEMENTS

Summary of key elements of the analysis of existing policy measures

The review of existing water policy measures shows that residential WuPs, in particular toilets and taps, receive the most focus in the schemes identified. Outdoor equipments receive the least focus.

No scheme or programme has been identified which introduces water efficiency requirements for industrial equipment and irrigation systems used in agriculture. Some programs promoting water saving in industrial settings exist. However, due to the diversity of products used in industrial settings, there are no specific requirements regarding the latter.

Most of the schemes have been identified in countries concerned by water shortage and droughts problems (Italy, Spain, Portugal, and Australia).

Within the EU, there appear to be no scheme equivalent to WELS. Most of the mandatory schemes either have a local coverage (Spanish and Italian schemes) or only target toilets (United Kingdom and Ireland Building Regulations).

Governments in MS have to date made little use of regulatory approaches and seem to prefer information instruments, such as labels and certificates.

6. ASSESSMENT OF THE NEED FOR AN EU APPROACH

6.1. INTRODUCTION

The main objective of this chapter is to evaluate the feasibility of introducing water efficiency standards at the EU level. In this sub-section, an analysis of the necessity and feasibility of developing and introducing standards for water using devices at the EU level is carried out.

Such evaluation requires analysis of two issues:

- Do actions and policy measures carried out and introduced by MS to improve the water performance of WuPs seem enough to tackle the water scarcity issue or is there a need for EU action on water scarcity?
- Is it feasible and efficient to introduce water efficiency standards at the EU level?
- If yes, and considering the range of possible tools (see chapters 4 and 5), which one would be the most appropriate?

The analysis takes into consideration whether introducing EU standards will deliver further benefits in comparison with the current situation and the potential environmental, social and economic impacts on different stakeholders (manufacturers, consumers, etc.). Furthermore, the potential advantages and disadvantages (e.g. in terms of costs and benefits) of such an approach at the EU level are analysed. To this end, different options are considered and analysed (mainly quantitatively and qualitatively when possible) in terms of their possible impacts. The results are presented in an ***impact matrix*** (policy options against impacts) and are commented on further.

Once the need for specific water standards at the EU level has been discussed, the priority WuPs that would need to be addressed are identified. To this end, different aspects are taken into account:

- Water performance
- Market patterns
- Potential for improvement: whether the technical possibility exists for improving and increasing water efficiency
- Product coverage: whether existing instruments and standards cover a specific product that according to its water performance and market trends should be addressed
- Effectiveness of existing requirements: whether the application of water efficiency standards and requirements are likely to bring about a reduction in

water use by the specific product in comparison to standard water performance
- Interaction with existing EU actions: whether streamlining with existing European legislation might be possible or required, or is already covered

6.2. NEED FOR AN EU APPROACH

6.2.1. ARE TODAY'S MS ACTIONS ENOUGH TO TACKLE THE PROBLEM?

The problem of water scarcity will be most important in certain regions of Europe. It is observed that the current geographical coverage of existing schemes, programmes and measures addressing and limiting the water consumption of WuPs is still quite heterogeneous, as shown in chapter 5. Most initiatives and instruments are identified in some southern countries which are concerned by water shortages and drought problems (such as Italy, Spain, and Portugal), as well as in the United Kingdom and Germany.

Furthermore, in most cases, most existing measures focus on a handful of WuPs, mainly in residential and commercial buildings, while other products are not considered. There is still considerable technical potential to increase the efficiency of WuPs, particularly in buildings. There is a wide range in the water-efficiency of different products, and the price of mains water should make it cost-effective for buyers to take water-efficiency into account.

The majority of responses collected by means of the questionnaire and interviews with experts agreed on the fact that it would be useful and feasible to develop and introduce water efficiency requirements for WuPs at the EU level. A common approach and requirements at the EU level would allow having the same targets and would help countries to achieve water efficiency in the same way. Furthermore, although the conditions of water resources management in Europe are very different due to climate, precipitation, population, land use etc., it might be reasonable to set basic minimum standards which have to be fulfilled all over Europe by certain water using devices (washing machines, dishwashing machines, flushing boxes, fittings, shower heads, etc.). Many water products are produced and marketed across the EU. In general, manufacturers usually prefer having a level playing field approach with consistent standards across EU MS. Therefore common requirements for key WuPs would be more acceptable if introduced at a European level.

None of the MS or stakeholders that replied to the questionnaire considered cooperation with neighbouring countries to be more relevant and efficient for the implementation of water efficiency measures.

6.2.2. ADDED VALUE OF EU ACTION

The recent growth in consumer demand for potable drinking water is unsustainable in the long term in the context of climate change scenarios and water scarcity foreseen in many different parts of Europe. If we continue to use water at the current level, we will have to provide more costly infrastructure in order to secure supplies which cannot, in any event, be guaranteed if rainfall continues to be intermittent, with longer periods of dry weather becoming the norm. There is also the considerable environmental and carbon cost of abstracting, treating and supplying clean, fresh drinking water to every home. When the need for a public intervention is clearly proved, the EU can present clear benefits in approaching adaptation in an integrated, coordinated manner at EU level. However, these advantages are closely linked to the specific impacts of the issue, which will determine whether subsidiary or EU action is more suitable.

The analysis carried out in previous chapters suggests that water efficient appliances such as toilets, showers, taps, washing machines, and dishwashers offer possibilities for water saving, and in some cases, equally diminishing the energy required to heat the water (e.g. taps and showers).

We can see that from the point of view of quantity, existing options seem able to bring potential savings in household consumption. For example, it has been previously estimated (EC, 2008 b) that installing water efficient appliances, e.g. by ecodesign, for all WuPs could represent total savings of 41% of household water use. In another study analysing potential savings resulting from the implementation of the National Energy Policy Act (USA), it was estimated that 55% of water savings could be achieved in households by 2006 (Vickers, 1993)[75].

At the national level, only the UK seems to have sufficient regulations in place, or coming into place, which address the water efficiency of different WuPs. At the local and regional level, other initiatives also exist, but in most cases, their impact is rather limited to those areas of application.

Apart from these local initiatives, the Water Framework Directive will participate in water abstraction reduction within a few years, as MS have to ensure good ecological health in terms of quantity and quality of water resources. More metering and more economically balanced prices could push for the reduction of water consumption. The main impacts could come from agriculture and industries, if real pressure were to be applied through the increasing of water prices for large consumers. However, the Ecologic study of 2007 shows that elasticity and farmers' behaviours were complex to model and to anticipate. CAP for instance is also playing a key role in water use. For "urban water uses", metering and pricing could also have an influence. However, it should be noted that today they are relatively more widespread in this area than in agriculture, and that the difficulty in finding a socially fair but efficient pricing hinders

[75] It should be noted that these projections presume that all pre-1994 fixtures have been replaced by a new generation of more efficient fixtures and appliances.

an important cut off. Further assessment on water saving potential deriving from the Water Framework Directive is an important issue in the evaluation of the *no further EU action option*.

With *no further EU action,* forthcoming reductions could mainly come from the Water Framework Directive, although with uncertainty of the level and effectiveness of the impact, and, with more certainty, from some MS initiatives, but with different and fairly low savings. It can be estimated that these savings will be roughly a few percent of the total water coming from water supply systems. The question is whether or not this will be enough to alleviate water scarcity risks.

Such analysis is of course limited by the diversity of the situation and by the fact that, for some areas, reaching even a small reduction is important to return to a more sustainable situation for groundwater or river ecosystem. This more qualitative approach is difficult to assess here, but on the whole, it does not seem to counterbalance quantitative gaps.

We have seen in chapter 5 that other reasons hinder the further development or success of MS initiatives. Among these are limited competencies to use adequate tools or limited area to reach interesting objectives, and the lack of communication or visibility of schemes. Technical or price barriers do not appear to be an important factor, though it has been reported in the UK that reaching a certain water reduction level should be studied thoroughly, as its main impacts are on the water supply and sewage system. It was also quoted that barriers are presented by the existing technical norms For example, the NF norms on taps fix a minimum flow of 12 litres per minute for each tap and this norm is mandatory for having the usual guarantee for the building. This slow development is rather surprising, considering that we have seen that easy and cheap measures can be installed on domestic uses.

However, the main reason is probably the lack of strong incentives for the public, public bodies, manufacturers and building designers to move to more water efficient fixtures or buildings. Water shortages are still perceived as being rare and natural events that are managed with curative tools such as water restrictions. Even when the high value of water is integrated widely, for some reason it has not driven global water reduction actions.

To fill this gap, the majority of responses collected from questionnaires and interviews agreed on the fact that it would be useful and feasible to develop and introduce water saving requirements at the EU level, as explained in the previous sub-section. The EU could provide this needed incentive. A common approach and requirements at the EU level would also allow the fixing of the same targets, and would help countries in the same way to achieve water efficiency.

On this point, it is important to underline that many water products are produced and marketed across the EU. Manufacturers are always a key stakeholder to consider when changing the market structure. In general, manufacturers usually prefer having a level playing field approach with consistent standards across EU MS. However, for some of them, adaptation to EU market changes can be more challenging than a limited number of MS changes. This point should be confirmed with a deeper analysis to investigate whether any water efficiency requirements would be more acceptable if introduced at a European level.

6.2.3. What approach or type of action would be more feasible and efficient?

EU policy action seems to be recommendable in the context of climate change and in order to harmonise transboundary approaches in the battle against water scarcity and droughts. As happens with energy savings, different potential policy options could be considered and adopted to address the water efficiency of products.

In this regard, chapter 5 characterises and analyses the different policy measures that were identified in chapter 4 which address the water performance of WuPs in Europe, MS and third countries. Whilst the inventory of existing schemes in chapter 4 differentiates between mandatory and voluntary measures, this initial characterisation is further organised along three types of policy measures in chapter 5: regulatory instruments (regulations, Directives, and mandatory performance standards), information instruments (labels and certificates) and voluntary agreements.

To date, few countries have opted for regulatory approaches to increase the efficiency of WuPs. On the other hand, the policy literature shows that regulatory instruments are highly effective in achieving their objectives, and provide clear and transparent procedures for affected businesses. The major benefit of norms and regulations, such as minimum or maximum performance standards is that (most) water savings are guaranteed. At the EU level, an extension of the Ecodesign Directive to cover WuPs (as adopted in April 2009) would permit the setting of mandatory minimum product requirements for market access, followed by specific regulations or the implementation of measures on specific product categories.

On the other hand, one of the major disadvantages, when compared to information instruments, is that they fail to create environmental awareness among the public. Where data is available, labelling and certification schemes, such as the Energy Star, the German Blue Angel or the Australian WELS have shown to be recognised by a large proportion of the public.

The majority of identified labelling and certification schemes currently in operation within and outside Europe are voluntary. In most cases, they address multiple environmental issues, such as the Blue Angel, Nordic Swan or Energy Star. Fewer initiatives target water efficiency exclusively.

In order to determine the most appropriate and efficient policy option to address water efficiency for WuPs at the EU level, different options have been considered and evaluated quantitatively and qualitatively. The options have been defined based on the existing policy measures described in chapter 4 and further analysed in chapter 5, namely:

1. **Option 1:** BAU, i.e. no further EU action
2. **Option 2:** Setting voluntary requirements for key WuPs through an EU labelling scheme, endorsement type. Such labelling scheme could consist of a dedicated label only covering WuPs such as in the case of the BMA label (United Kingdom) or a label addressing multiple environmental issues (like the label from Cataluña).
3. **Option 3:** Setting mandatory requirements through a **mandatory EU label,** consisting of a ranking system for the water efficiency of key WuPs, such as the Australian WELS labelling scheme.
4. **Option 4:** Setting mandatory requirements for key WuPs through the extended Eco-design Directive (e.g. implementing measures)
5. **Option 5:** Creation and promotion of voluntary agreements with industry

There options for EU action are further evaluated in the following sub-section.

6.3. POLICY OPTIONS AND THEIR PROS AND CONS

A combined qualitative and quantitative approach is adopted for the analysis of the options proposed in the previous sub-section. For each of the issues, the relative advantages and disadvantages of the options are evaluated here.

Regarding the proposed options, it is important to highlight that, during the duration of this study, in April 2009 the Parliament and Council adopted the proposal from the European Commission to extend the scope of the Ecodesign Directive to cover energy-related products (e.g. shower heads and taps) and consequently this will become the Business as usual (BAU) option. Nevertheless, given its recent adoption, for the purpose of this study, the introduction of mandatory requirements for key WuPs through regulatory instruments (which would correspond to the Ecodesign Directive implementing measures) has been considered as a possible option for the adoption of an EU approach. Further, it could cover "all water-using products" including those which may not have an influence on the energy consumption and thus cannot qualify as "energy-related products" in the context of the Ecodesign Directive (e.g. toilets).

Option 1: BAU, i.e. non action

Pros:

- No additional burden on manufacturers from additional legislative requirements.
- Leaves MS the freedom to determine optimal control requirements for WuPs according to the regional context regarding water availability.

Cons:

- Missed opportunity to reduce water use where quantitative aspects are not the priority but could be a growing concern.

- Possible inconsistency of approaches between MS/regions, leading to impacts on competition among European manufacturers.

Option 2: Setting voluntary requirements for key WuPs through an EU labelling scheme

Pros:

- Involves both manufacturers and users.
- Opportunity to introduce standards which go beyond existing regulation and therefore encourage environmental 'front-runners', thereby creating a competitive advantage for companies.
- Addressing water performance of products through a labelling scheme might create an increased awareness among customers and encourage them to buy more water-efficient products.

Cons:

- The development of water performance criteria and requirements would have to be developed for the identified WuPs, which could signify considerable time and costs, particularly to ensure that EU MS, stakeholders, etc. all agree upon them.
- Some national and regional eco-labels and certification schemes already introduce specific water efficiency requirements. Such schemes and programmes would have to be modified in line with the new requirements to be introduced at the EU level through the new EU labelling scheme, with the consequent additional administrative costs.
- Experience from the voluntary EU Eco-label has shown that the two major weak points regarding voluntary labelling schemes include low awareness from consumers and low uptake by industry, therefore these issues would need to be addressed.

Option 3: Mandatory EU labelling consisting on a ranking system for the water efficiency of key WuPs

Pros:

- Involves both manufacturers and users.
- Puts fewer burdens on manufacturers as only the rating against the label is mandatory, and so there are no direct requirements on products.
- Encourages a higher level of market transformation than voluntary programmes, and ensures a level playing field across all sectors covered.
- Fair competition and avoidance of free riders.

- The introduction of a water efficiency labelling scheme might create an increased awareness among customers and encourage them to buy more water efficient products
- Create consumer awareness on environmental issues and possibilities for consumers to compare water performance between products.

Cons:

- Need to introduce the appropriated regulatory framework, which would represent significant legislative burden (the mandatory labelling scheme could be similar to the structure and format of the EU energy label, otherwise a new scheme would need to be developed).
- Need for market surveillance, market introduction in order to identify new technological improvements, market share and application to new products.
- Continuous revision needed in order to clarify requirements, correct inconsistencies and omissions, and improve the effectiveness of the initiative.
- Bureaucracy burdens the operation of the scheme and an active government and parliament rather than the market drive it.

Option 4: Setting mandatory requirements for key WuPs through the extended Eco-design Directive (e.g. implementing measures)

Pros:

- Greater harmonisation among the MS.
- Strong signal to both users and manufacturers
- Encourages a higher level of market transformation than voluntary programmes, and ensures a level playing field across all sectors covered.
- The legislative framework is already in place with the extension of the Ecodesign Directive to cover energy-related products (e.g. taps, shower heads, cleaning equipment, etc)

Cons:

- Additional burden on manufacturers for compliance
- Additional burden on MS authorities for implementation and market surveillance, monitoring and enforcing compliance to requirements
- Acceptance in countries where there is no water quantity concerns.
- EU wide implementation would need requirements which are acceptable to all standards and might therefore be weaker than voluntary standards or initiatives in MS.

- In comparison with information instruments (e.g. labelling schemes), it would be less successful in creating environmental awareness among the public.
- Under the recent extension of the scope of the Ecodesign Directive, products that are not energy-related are not covered in spite of their potential for improvement and the significant contribution of some of them to total water consumption of buildings, such as toilets.

Option 5: Creation and promotion of voluntary agreements with industry

Pros:

- Good acceptance amongst the industry
- Legislative background in place
- Some voluntary agreements already exist at the European level between manufacturers and the Commission for other product groups (e.g. EU codes of conduct established between the Commission and different companies to improve products' energy demand management)

Cons:

- National differences in product politics and differences in the actual water scarcity situation (no real pressure in northern EU countries vs. water scarcity in the southern EU countries)
- Not addressing the problem of consumers awareness

All the proposed options (except the Business as usual) are intended to impact most of the aspects. However, the magnitude of these impacts may vary from one option to another.

6.3.1. ANALYSIS OF OPTIONS

This section goes into further analysis of the policy options that have just been proposed and is divided into the different issues to be considered under the various policy options including: legislative/policy issues, environmental issues, economic issues, social issues, and other issues.

6.3.1.1 Legislative and policy issues

- All the options (except option 1 - BAU) aim to address, improve and promote water efficiency of WuPs at the European level.
- It is mainly the implementation of options 2 and 3 that would require changes in the EU legislation and hence the impact of these options would be negative in this aspect. However, these options, along with option 4, could be

advantageous in terms of harmonisation by introducing the options at the EU level. Indeed, there is a great variety in the requirements among the schemes identified within the EU (see chapters 4 and 5).

- An important aspect that has to be taken into account when considering the introduction of water efficiency standards at the EU level is the possibility of streamlining and achieving synergies with existing legislation, and the possible impacts. For example, in the case of options 2 and 3, it would be possible to introduce minimum water efficiency standards via amendments to already existing legislation because voluntary and mandatory labels i.e. EU Eco-label and EU energy label respectively, already exist. However, this option would require the development of new criteria for different existing products and new product groups to be covered. In addition, as these labels are more focused on aspects such as energy use and the environmental impacts associated with the overall life-cycle of the product, the product's water consumption could be seen as less important by consumers if a separate water labelling scheme was not established.
- A labelling scheme (whether it be voluntary or mandatory), as is specified in options 2 and 3, could provide an incentive to companies to innovate in product design or production processes, in order to obtain the label for their product in the future. In addition, should a labelling scheme be decided upon, it would be important to analyse the different forms in which the label would be present. This is because, as experiences with other labelling schemes have shown (see section 5.5.2 pg. 210), voluntary schemes frequently struggle to motivate manufacturers to participate, whereas mandatory labels and certificates provide higher incentives for manufacturers to increase the efficiency of their products. It is also important to note that voluntary labels indicate that a product is water efficient but unlabelled products are not necessary inefficient. This problem would not arise in the case of mandatory labels.
- In the case of option 4, the recently revised Ecodesign Directive (April 2009) presently provides a framework for setting compulsory minimum requirements and voluntary benchmarks for WuPs (both washing machines and dishwashers are covered by the Ecodesign Directive already, and working documents on a possible Commission regulation implementing this Directive with regard to household washing machines and dishwashers have already been circulated). All energy-related products, i.e. those that do not consume energy during use but have an indirect impact on energy consumption, are also expected to be covered in the future. This will allow the EC to address additional WuPs, including water-saving taps and showerheads. On the other hand, the revised Ecodesign Directive does not cover in principle other products that are not energy-related, such as toilets, which still have a significant contribution to total water consumption of buildings and a large potential for improvement.

Therefore, complementary measures would have to be implemented, thus resulting in additional administrative costs.

- Another option would be the combination of options 2, 3 and 4: a voluntary and mandatory labelling scheme, in addition to setting compulsory minimum water efficiency requirements. This would entail for example, a mandatory label for certain WuPs (i.e. shower heads, toilets, taps, washing machines, and toilets) for which a significant amount of information already exists on possible water efficiency standards. This would make it somewhat easier to set mandatory minimum water efficiency standards for these products, whereas for WuPs where less information exists (i.e. WuPs found in industry, and outdoor WuPs), a voluntary endorsement label could be used to ensure that these products are addressed. This schematic is similar to what is currently being done in Australia with the mandatory WELS labelling scheme, (which covers key WuPs such as toilets, taps, shower heads, washing machines, and dishwashers), and the voluntary SmartWaterMark label (which covers outdoor WuPs such as garden irrigation equipment and car washes). However, it is also important to consider the possible confusion that the existence of several environmental labels can cause for consumers. To overcome this, it will be important to implement several information campaigns to raise public awareness on the existence of such labels. Finally, in a mid to long-term perspective, once further studies are set out and information gathered on the particular WuPs for which more information is needed, mandatory water efficiency requirements for these products can be set and they can be included within the overall mandatory labelling scheme.
- Finally, in the case of option 5, the legislative framework already exists for the establishing of voluntary agreements. In 1996, the Commission adopted a Communication to the Council and the European Parliament on environmental agreements. Environmental agreements were at that time a new policy instrument to supplement regulatory measures. A second Communication on Environmental Agreements was adopted on 17 July 2002. The Union is currently striving for environmental agreements in a number of specific fields such as waste management and climate change. Regarding climate change, an example is the agreements committing the automobile manufacturers to reduce CO_2 emissions from passenger cars mainly by means of improved vehicle technology.

6.3.1.2 Environmental Issues

The downside of a product approach (options 2, 3, 4 and 5) compared to a system approach (e.g. introducing overall minimum water efficiency standards via amendments to the existing EPBD) is that it would be possible to comply with the minimum standards in key components such as showers, toilets and taps, but have high water using items such as aerated spa baths if they are outside regulation.

➢ **Potential water savings**

In order to evaluate the potential environmental impact of each option, an estimation of the potential water savings that could be achieved if water-efficient WuPs (toilets, taps,showers, baths and outdoor WuPs) were fitted in an average European household is used (see below).

To determine the effectiveness of each option, it was necessary to calculate the savings in EU water consumption. The following subsections will outline the methods by which savings figures were reached, as well as the results of the analysis. The potential water savings were calculated using the following assumptions:

- Without any EU action (Option 1), water efficient WuPs will be found in 5% of European households (BAU scenario).
- Assuming a market share of 10% (the current goal for EU Eco-labelled products), we would consider that 10% of households would be equipped with water efficient WuPs in Option 2.
- As for Option 3, introducing a mandatory raking label could lead to a change in the distribution of WuPs according to their water consumption. This could lead to a range of savings across European households. Those products which do not receive ranking would follow a BAU scenario.
- Option 4 could lead to 100% of households being equipped with water efficient WuPs. However, according to the most recent legislative developments (i.e. adopted extension of the Ecodesign Directive), this option also allows for legislating only energy-related products such as taps, showers and baths, meaning others would follow a BAU scenario. As dishwashers and washing machines are legislated under the Ecodesign Directive, it was assumed that savings for these products would be the same regardless of which of the above options is implemented.

■ **Household consumption and savings**

To determine the potential savings that could be reached by the implementation of each option it was necessary to determine the current water consumption scenario in Europe. The yearly consumption per household was determined for individual product types based on those figures calculated earlier. As well as including the volume per flow (eg L/min), the number of uses per person including the number of uses per day, and use factors (eg amount of time spent washing) is included. Totals have been based on consumption for a European household, with an average occupancy of 2.5 persons (European Environment Agency, 2001). The total consumption per product is shown below in Table 79.

Table 79: Product contribution to water consumption

Product	Taps	Shower	Bath	WC (full)	WC (short)	Washing machine	Dishwasher	Outdoor
Consumption (l/capita/day)	13.0	42.9	11.4	13.2	26.7	14.7	11.4	4.3
Total consumption (l/household/yr)	11 871	39 134	10 436	12 023	24 411	13 462	10 436	3 926

The sum of the consumption per capita figures corresponds to a total of 137.7 l/capita/day or 125 698 l/household/year. The former figure is in line with that identified in a previous study on the water savings potential published in 2007 (*Dworak , 2007*), which estimates the consumption at 150 l/capita/day. This figure was reached by determining an average consumption in Europe in the 1990s.

One of the reasons figures may differ is that standard products have changed since then. With a greater number of water saving products available on the market, this figure could have decreased since then. Furthermore, it is not clear how the original data was gathered, or which products were included in the analysis. However, the data determined here seems to be in line with average European consumption, so it is assumed that the following figures will be an adequate representation of the potential savings induced by each option.

The consumption figures for water efficient products were also based on those gathered in Table 49 (pg.111). As noted earlier, dishwashers experience the greatest decrease in consumption with an average of 55%, followed by toilets with an average of 53% (including both long and short flushes), and washing machines at 32%. Replacing all the standard residential WuPs considered here for water efficient products would amount to an overall decrease in yearly consumption of around 32%, or 40 716 litres for an EU household.

Table 80: Water saving potential per product type

Product	Consumption (l/household/year)		Decrease in water consumption	
	Present scenario (l/household/yr)	Water saving scenario (l/household/yr)	Amount (l/household/year)	Percentage
Taps	11 871	9 131	2 739	*23%*
Shower	39 134	31 307	7 827	*20%*
Bath	10 436	8 479	1 957	*19%*
WC (full)	12 023	7 594	4 430	*37%*
WC (short)	24 411	11 563	12 848	*53%*
Washing machine	13 462	9 199	4 263	*32%*
Dishwasher	10 436	4 696	5 740	*55%*
Outdoor	3 926	3 013	913	*23%*
Total	**125 698**	**84 982**	**40 716**	**32%**

Using the figures gathered here, the following subsections outline in detail the potential savings that could be achieved with each option.

- **Option 1**

The first option is based heavily on the assumption that although no voluntary or legislative instruments will be put in place, a number of houses will nevertheless become equipped with efficient WuPs. For the purposes of the analysis, this figure was assumed to be approximately 5%. The reduction potentials were then calculated based on a total yearly EU public water supply of 41 trillion litres of water. This corresponds to a total saving of 0.3 trillion litres of water, or 0.7% of the yearly public water supply. This figure does not include dishwashers and washing machines, which will be covered under the Ecodesign Directive.

- **Option 2**

This option is based on the assumption that 10% of households will be equipped with water efficient WuPs. This amounts to a 1.5% decrease in consumption from the yearly EU public water supply, or 0.61 trillion litres of water. Note that once again this figure does not include dishwashers and washing machines, which will be covered under the Ecodesign Directive.

- **Option 3**

Unlike options 1, 2 and 4, the decrease in consumption is not based on a single reduction percentage per product. As this option is based on the introduction of a mandatory ranking label it was necessary to first determine the distribution of products according to their rank (and therefore, their consumption) in a decade's time. As no similar ranking system for WuPs has been in force long enough in Europe, the results of the Australian WELS scheme have been used as a basis to determine the distribution of standard vs efficient products (*Chong et al, 2008*). Some modifications have been made to the consumption figures determined earlier in this study in order to fit the WELS ranking system. For example, a standard or inefficient shower consumes water at a flow rate of 10 l/min in Europe, where as the same quality is assigned to a shower with a flow rate of greater than 16.5 l/min, according to WELS. A customised ranking system has therefore been devised for the purposes of the analysis, as determined below in Table 81. It is worth reminding here that distribution figures correspond to the predicted market shares for each product within 10 years.

Table 81: Distribution of products by rank and consumption range

Product	WELS Rating	Market share	WES Equivaltent	Consumption Range
Showers	0 star	30%	Inefficient	10.0 - 9.0 l/min
	3 star	67%	Median	8.5 - 7.5 l/min
	5 star	3%	Efficient	7.0 - 6.0 l/min
Taps	0 star	50%	Inefficient	6.5 - 5.5 l/min
	3 star	45%	Median	5.0 - 4.0 l/min
	5 star	5%	Efficient	3.5 - 2.5 l/min

Product	WELS Rating	Market share	WES Equivaltent	Consumption Range
Toilets	0 star	14%	Inefficient	9.5 - 7.0 l/min
	3 star	67%	Median	6.5 - 4.0 l/min
	5 star	19%	Efficient	3.5 - 3.0 l/min

Based on the above distributions, the next steps involved the calculation of minimum and maximum potential savings. As the above distribution must be applied across the EU residential sector, it was necessary to determine the total amount of time each product is used yearly across all households. In the case of toilets, the number of times was not determined as no time factor has been used in the calculation of consumption. Using taps as an example, the product is used 12 times daily per person, for 10 seconds each time (0.2 min). For a house of average occupancy (2.5 persons) this corresponds a yearly consumption time of approximately 1 826 minutes of use per year. There are approximately 197 million households in Europe[78] and this corresponds to a total use time of just below 360 billion minutes of taps use across EU households. SeeTable 82 below for a breakdown of total use per product.

Table 82: EU product use factors

Product	Use factor	Uses/day	Annual use per household	Total annual use in EU
Showers	5 min	0.9[a]	3 913 min	7.7E+11 min
Taps	0.2 min[b]	12.0	1 826 min	3.6E+11 min
Toilets	33% full 67% short	4.2	3 835 flushes	7.6E+11 flushes

[a] Assuming 6 showers per week
[b] Assuming 10 second use time

It is therefore assumed that use is divided among products of different efficiency according to their market share. Continuing to use taps as an example, the total use time is divided into 50% use for an inefficient product, 45% for a product of median efficiency, and finally 5% for an efficient tap. Using this method it was possible to determine the decrease in consumption for each of these products, taking into consideration both the minimum and maximum potential savings, as shown in Table 83.

Table 83: Minimum and maximum potential water savings per product

Product	Present EU consumption (billions of litres per year)	Consumption with mandatory label (billions of litres per year)		Percentage Savings	
		Minimum	*Maximum*	*Minimum*	*Maximum*
Showers	7.71	6.87	6.09	11.0%	21.0%
Taps	2.34	2.04	1.68	12.7%	28.1%
Toilets	7.18	5.79	4.85	19.3%	32.4%

[78] See footnote 41.

If we consider a yearly EU public water supply of 41 trillion litres, the above savings correspond to a reduction of approximately 3.0 to 5.0 trillion litres of water (7.3 to 12.1% reduction) (Table 84). It is important to note here that although the reduction of consumption for baths and outdoor products has been included in the analysis, ranking has not been applied to these products. Instead, it is assumed that the distribution of water efficient products will follow a BAU scenario (approximately 5% of households with water efficient WuPs). Once again, those products already covered under the Ecodesign Directive have not been considered here.

Table 84: Minimum and maximum potential reduction from EU public water supply

Scenario	Potential EU public water supply savings	
	litre/year	*Percentage*
Minimum	3.0E+12	7.3%
Maximum	5.0E+12	12.1%

- **Option 4**

Option 4 relates to the introduction of mandatory requirements which would involve the replacement of all the concerned WuPs with their water efficient counterparts. If we exclude dishwashers and washing machines (already covered under the Ecodesign Directive), this equates to a total reduction of 14.8% of the annual EU public water supply (approximately 6.1 trillion litres of water).

It is worth noting that it has been proposed that the revised Ecodesign Directive should cover in principle only energy-related products. This would apply in particular to showers, taps and baths, which are supplied with hot water. If the legislation covering EuPs were extended to include these products, and thereby set standards for water consumption, it is assumed that savings for these three products would be approximately 6%, or 2.5 trillion litres of water.

- **Considering existing requirements established in the Ecodesign Directive**

Water saving requirements could potentially be included within the scope of the Ecodesign Directive. As the exact consumption requirements are still under discussion, the calculations in this section have been based on an average reduction figure based on those requirements listed in sub-section 4.3.1. As this type of legislation is mandatory in nature, it is assumed that 100% of household dishwashers and washing machines will be replaced by water efficient WuPs. This means that the reduction of public water consumption for these products would be the same across all four options. As shown in Table 85, this equates to an additional 4.8% reduction in public water supply across all four options.

Table 85: Potential public water supply savings from efficient washing machines and dishwashers

Product	Total household consumption (l/household/year)		Savings		
	Standard	*Efficient*	*per household*	*Total EU*	*% of public supply*
Washing machine	13 462	9 199	4 263	8.4E+11	**2.0%**
Dishwasher	10 436	4 696	5 740	1.1E+12	**2.8%**

If we were to consider this additional reduction, then the total potential reductions for each option would be as shown below in Table 86.

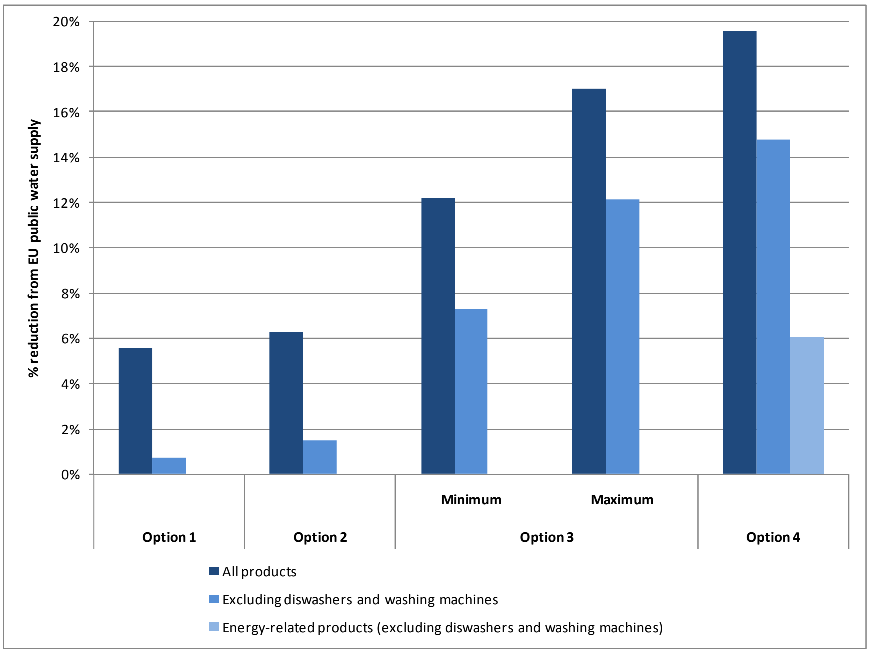
Table 86: Total savings considering washing machines and dishwashers (currently covered by the Ecodesign Directive)

Scenario		Water savings in EU public water suply	
		l/year	*%*
Option 1		2.3E+12	5.5%
Option 2		2.6E+12	6.3%
Option 3	Minimum	5.0E+12	12.2%
	Maximum	7.0E+12	17.0%
Option 4		8.0E+12	19.6%

- **Summary of potential public water savings**

To summarise the above findings, the percentage by which each option reduces EU public water supply has been presented in Figure 75. It is clear that the introduction of mandatory requirements (Option 4) would induce the greatest savings if all products are included. However, if only energy-related products are included (without considering dishwashers and washing machines), the reduction is much lower, at around 6%. This is slightly lower than the minimum reduction potential of option 3 which introduces a mandatory ranking label. In comparison with the latter options however, the reduction potentials of options 1 and 2 are considerably lower. This may not be surprising for Option 1, which follows a BAU scenario. However, option 2 would require some effort to introduce a voluntary label and considering the low potential for reduction, the value of following this option is debatable.

Figure 75: Potential public water savings for each option



Potential savings in total abstraction

Reducing the **household** consumption by a maximum of approximately 8.0 trillion litres results in a 3.2% reduction from the annual **total EU water abstraction**[79]. In a recent working document published by the EC, it was determined that the domestic sector accounts for 24.4% on the EU water consumption. Potentially reducing consumption by a stated 25% would result in a decrease in 6.1% of total EU water abstraction. However, the 25% reduction refers only to reduced consumption in households. If we consider that households make up 70% of the domestic sector (*Dvorak et al, 2007*), this percentage is reduced to a 4.3% reduction of the total water abstracted. Although still higher, this figure corresponds more closely to the results determined in this study.

Potential energy and CO_2 savings

Reducing the water consumption of products such as taps, showers and baths can also result in an indirect reduction of energy consumption. Taps, showers and baths could, therefore, be potentially included under the Ecodesign Directive as energy-related products. Taking into account only these products, a possible reduction of 2.5 trillion litres of water is equivalent to reducing the total amount of abstracted water by 1%. Altogether, replacing standard toilets, taps and showers for their water efficient alternatives results in a water consumption decrease of approximately 20% (for these products only), as shown in Table 87.

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[79] Total abstraction refers to water destined for all sectors including both residential and commercial buildings, industrial and agricultural. This is approximately 247 trillion litres of water per year (*Dvorak et al, 2007*)

Table 87: Estimated water savings following replacement of standard taps, showers and baths with water efficient alternatives

Product	Consumption (l/household/year)		Reduction	
	Standard product	Water efficient alternative	l/year	%
Taps	11 871	9 131	2 739	23%
Showers	39 134	31 307	7 827	20%
Baths	10 436	8 479	1 957	19%
Total	**61 440**	**48 917**	**12 523**	**20%**

It is assumed here that the energy consumed by household water heaters is destined solely for use by these products. As water heaters currently use approximately 92 TWh of primary energy in the EU per year (*Kemma et a.l, 2007*), this would result in a potential 20% reduction in water heater use, or approximately 18.4TWh/year. This is equivalent to savings of 0.59% of total EU primary energy supply[80]. Considering that the consumption of 1TWh or primary energy equates to 0.157 $MtCO_{2eq}$ emissions[81], introducing mandatory water saving measures would correspond to yearly CO_2 savings of approximately 2.89 $MtCO_{2eq}$ if standard energy-related WuPs are replaced (excluding dishwashers and washing machines).

6.3.1.3 Economic issues

Two forms of economic impacts exist: the impacts on manufacturers and the impact on the regulatory authorities.

- **Impact on manufacturers**

The economic impact on companies refers here to the cost implied by compliance to each option. These costs include for example registration costs, which depending on the requirements of the selected option, can entail costs associated with testing the product to ensure it meets the specific standards or requirements, payment of registration fees, and the resources and staff required to complete the registration process.

In general, the advantage of an EU approach (options 2 to 5) would be the adoption of requirements recognised in all MS, which would prevent the development of multiple schemes developed by individual MS, which could require replicated testing/rating/registration requirements for manufacturers.

In the event that a voluntary label is put in place (option 1), each manufacturer can decide whether or not to present its products for certification. Thus the impact ranges from 0 (no impact) to "-" (negative, the company has to make sure its products meet criteria and has to pay for the certification).

[80] Based on 3,086 TWh net production in EU 27. *Eurostat 2009*

[81] Based on Ecoreport tool

The expenses that manufacturers have to bear are logically higher in the case of mandatory measures (option 3 and 4). However, in most cases, manufacturers have already developed lines of water-efficient devices (in most cases, as it happens), and therefore the economic effort will be lower (hence the ranges of impacts in the matrix).

One important aspect to take into consideration regarding the potential impact of introducing a labelling scheme (options 2 and 3) is the potential fees to obtain and maintain the label. Available information in this regard (chapter 5) suggests that the costs can vary considerably (e.g. from 330€ in the case of the Catalonian Environmental Quality Guarantee label, or 830€ for the Australian WELS up to 1,300€ for the EU Eco-label). If required, the annual fee could also represent an important burden for some companies (e.g. costs up to 0.15% of annual volume of sales of the product within the Community, with a maximum of 25 000€ per product group per applicant in the case of the EU Eco-label).

- **Impact on public authorities (budget and resources)**

Option 3 would require more resources than option 2 since it would mean the implementation of a new European instrument whereas option 2 could rely on existing initiatives (e.g. the EU Eco-label).

Impacts of option 4 can be more or less significant depending on whether a compliance control system is put in place and if costs are paid for by the EU or MS. In any case, options 1 to 4 would all imply administration costs that would include for example, running awareness campaigns, developing technical standards, enforcement and compliance activities, staffing, and costs associated with operating a dedicated website and communication.

Option 5 would be the option with the lower economic impacts for public authorities.

6.3.1.4 Social issues

An important aspect that has to be taken into account is the consumers' behaviour, which, as shown in chapter 3, can have a most relevant impact on water consumption. Unfortunately, available information suggests that in general, awareness about water scarcity issues is low. In this regard, opportunities to increase water-efficiency may be passed up because of low awareness of water issues and water prices, poor access to water efficiency information during product search and selection and because products are often chosen by intermediaries such as builders or plumbers, rather than by the party who will bear the ultimate running costs.

In this regard, options 2 and 3 would contribute to overcoming lack of information and awareness through water efficiency labelling, the aim of which is to ensure that buyers are presented with information on water efficiency and/or water use at the time and in the form that is most likely to influence their purchase decision. On the other hand, a drawback of information measures is the existence of many different labelling and certification schemes, which could happen in the case of the development of a dedicated label for WuPs (such as the Australian WELS), rather than integration into existing EU labelling schemes (e.g. Eco-label or energy label). In this regard, one of the major disadvantages of mandatory measures through regulation (option 4), when compared to information instruments, is that they fail to create environmental awareness among the public.

More harmonisation and better interpretation will lead to a more uniform approach on a European level. This may also affect the public confidence in regulatory measures. On the other hand, overregulation of a sector may also cause scepticism, harm the trust of the public and give the impression of misgovernment (option 3 and 4).

6.3.1.5 Other issues

Options 2 and 4 seem to be the most appropriate, cost-efficient and feasible from a legislative point of view given the current legislative framework. On the other hand, option 4 would be the one with the highest administrative burden for public authorities and economic impact on manufacturers. It would also be advisable for this option to take into consideration local water resources contexts.

In terms of consistency with other existing legislation, options 2, 3, and 4 will overlap with some of the local and national regulation identified in previous chapters.

For options 2, 3, and 4 in some cases, and for some products, standards will have to be developed. Three separate types of standards would be required: the water efficiency tests themselves, and the minimum performance levels which products must meet. In the case of options 2 and 3 and for rating schemes, standards will also be required on the levels of efficiency required for successive ratings (“algorithms”).

6.3.1.6 Summary of analysis of options

The impact assessment matrix presented below in Table 88 summarises the results of the analysis. The arguments behind the rating are then explained further below.

In each cell a qualitative score of Y/N or ‘+’, ‘0’ or ‘-‘, has been given. A ‘+’ signifies a beneficial impact with respect to the criterion in question; ‘-‘, a negative impact; and ‘0’ no impact. Increased magnitude of the impacts will be indicated using the notation ++ or --. In some cases, when there are other external influencing factors, a range is used, for example 0 to – or even + to -.

Table 88 : Impact assessment matrix of options

	Option 1: No Action	Option 2: Voluntary requirements for key WuPs* through an EU labelling scheme	Option 3: Mandatory EU labelling of the water efficiency of key WuPs	Option 4: Mandatory requirements for key WuPs though regulatory instruments	Option 5: Creation and promotion of voluntary agreements with industry
General Issues					
Issue addressed[82]	N	Y	Y	Y	Y

[82] This question looks at whether the design of the option actually addresses the real problem – in the

	Option 1: No Action	Option 2: Voluntary requirements for key WuPs* through an EU labelling scheme	Option 3: Mandatory EU labelling of the water efficiency of key WuPs	Option 4: Mandatory requirements for key WuPs though regulatory instruments	Option 5: Creation and promotion of voluntary agreements with industry
Legislative change	N	Y	Y	Y	N
Environmental Issue					
Potential Water Savings	0	0 to +	+	++	?
Economic Issues					
Impact on firms: cost	0	0 to -	-	- to --	-
Impact on public authorities (budget; resources)	0	-	- -	- to --	-
Social Issues					
Confidence of public on environmental control	-	+	- to +	+ to ++	+
Other issues: Practicability and Enforceability					
Practicability: is it practical to implement?	n/a	Y	Y	Y	Y
Clarity and consistency (e.g. with other national and EU legislation)?	n/a	Y/N	Y/N	Y	Y/N
Is it enforceable?	n/a	Y	Y/N	Y/N	Y

Note: '++': substantial beneficial effect; '+': slight beneficial effect; '-': negative effect, '--': substantial negative effect; '0' no effect; N/A: Not applicable; Y/N: yes/no.
*__Key WuPs__: WCs, taps, and showerheads.

6.4. IDENTIFICATION AND PRIORITISATION OF WATER-USING PRODUCTS FOR EU ACTION

6.4.1. WATER CONSUMPTION

As shown in Table 48 (pg. 110) and Figure 36 (pg. 110), WCs, showers, taps and washing machines consume the most water per household on a daily basis (31%, 33%, 10%, and 11% of the total water consumption in an average household respectively). Although dishwashers and outdoor WuPs also consume a notable amount of water, they may not be as high a priority as the former four products. If we were to base the prioritisation of commercial WuPs on Figure 8 (pg. 38) and Figure 9 (pg. 39), it would seem that the most significant products in terms of average percentage of water consumption are sanitary WuPs (such as taps, WCs and urinals), followed by cooling towers, kitchen WuPs (such as dishwashers and taps), and showers. In relation to the first two categories, average water consumption per day has been calculated and is

sense of focus rather than effectiveness. Effectiveness issues come after. Hence it is the intention and targeting of the option that is assessed here and not its effect.

listed in Table 50 (pg. 112). This table shows that WC water consumption is much higher than that for urinals and cooling towers. However, it is difficult to determine the priority of commercial WuPs in relation to one another based on water consumption alone. As each product is used in different domains and with different frequencies, the level of variation in their use makes it difficult to determine their average total water consumption per day. Also, the gaps in available data contribute to further obfuscating the significance of each product. Therefore, other factors such as saving potential and market trends are also crucial in prioritisation.

With data lacking for the overall water consumption by industrial WuPs, it is difficult to tell which products consume the most significant amount of water within this sector. Furthermore, water consumption of products such as cooling towers and boilers is heavily dependent on the types of industry they are employed in, and so setting universal standards may at best be a challenge in this sector.

6.4.2. INTRINSIC WATER SAVING POTENTIAL

Many alternatives have been identified for each of the residential products listed. In particular, those products that may be retrofitted with new technology could be considered to have a high potential for improvement. Showers, taps and WCs may all be fitted with retrofit devices to increase their water efficiency. Furthermore, these products also have a variety of alternative counterparts which are considered to be more water efficient.

Water saving potential for commercial WuPs can also be analysed based on the introduction of new or alternative technology and gadgets that contribute to lower water consumption. The majority of sanitary WuPs can increase efficiency with the introduction of flow limiting devices or reducing the amount of consumption per use (such as reducing the amount of water per flush). Dishwashers and clothes washers are also available which consume less water, such as those which reuse water per cycle. Other types of commercial products may also significantly reduce water consumption by altering the type of cooling system used. Ice makers and cooling tower water consumption may be significantly reduced by using air cooled systems instead of water cooled systems. Although it can be safely said that all products in sub-sections 3.1.3 (pg. 40) and 3.2.3 (pg. 116) have the potential to reduce intrinsic consumption or be replaced by alternative technologies, it is again difficult to determine the significance of each product relative to other products based on their water saving potential.

As a vast amount of water savings can be brought about by correct management of industrial WuPs, it is believed that a change in technology may not be the best option for some industries. Water saving alternatives for cooling towers such as dry cooling systems, may conflict with other broad environmental goals such as the reduction of energy consumption. Industrial cleaning equipment also has few water saving alternatives, although by introducing new standards, manufacturers may be encouraged to provide new water efficient technologies.

6.4.3. Market trends

Though information on market trends gathered to date may not provide a clear view of the market status for individual domestic WuPs, it is still possible to reach a preliminary overview of the current state of the market. Those products related to personal sanitation (i.e. showers, WCs and taps) appear to hold a large share of the market with many millions of products produced each year in Europe. Conversely, dishwashers, and especially cooling systems used in buildings (e.g. mini coolers, evaporators) appear to have a much smaller share of the market when compared to other products. It is assumed that the production of all domestic WuPs will experience some growth in the near future, particularly those related to personal sanitation.

With the exception of commercial car washers, the majority of commercial WuPs appear to be facing a growing market trend. It is important to note that those statistics collected for sanitary and laundry related WuPs have been found in conglomeration with those of their residential counterparts. With changes in the current economic climate, sales of these products may drop in the near future, as fewer new buildings are constructed. However, in the long term this may affect business owners' decisions about which WuPs they install in new buildings and during renovation, where there may be a push to decrease the cost of water bills. This last point however would only be considered significant in areas where water is distributed to the end-user at a price.

Although market trends for cleaning equipment were unavailable, the data available for other industrial WuPs seems to indicate that cooling towers and boilers are experiencing a downturn in production in Europe. This may indicate a downward trend but it does not give a clear picture of the numbers of these products imported or exported in Europe.

6.4.4. Interaction with existing EU actions

As EuPs, washing machines and dishwashers are included within the scope of the Ecodesign Directive (lot 14). On 31 March 2009 the Regulatory Committee adopted requirements for washing machines and an updated version of the energy labelling Directive for washing machines. Apart from the link between energy and water consumption, some requirements directly deal with the water performance of washing machines (e.g. water consumption limits of the 60°C full-load program). Likewise, an updated working document for dishwashers is awaiting approval from the Regulatory Committee. It also contains direct requirements regarding water consumption of dishwashers[83]. It can be concluded that there is no need for other EU actions regarding water efficiency of washing machines and dishwashers.

[83] http://www.eceee.org/Eco_design/products/domestic_wet_appliances

6.4.5. COVERAGE AND EFFECTIVENESS OF EXISTING SCHEMES

Chapter 5 deals with the effectiveness of each scheme and highlights the fact that some key WuPs like toilets, taps and showerheads are more often covered. The question here is whether all the schemes identified are sufficient from an EU point of view. In fact, despite sparse initiatives, inefficient WuPs in terms of water efficiency are still in use and sell within EU.

6.5. CHAPTER KEY ELEMENTS

Summary of key elements regarding the need for an EU approach

The BAU scenario would mean that the water efficiency of different WuPs will only be promoted through existing schemes at the EU and MS level, whose scope and product coverage is still limited. With the rise of environmental consciousness, the adoption of water efficient WuPs eventually will become the norm where there is no specific regulation in this regard (e.g. in the majority of the EU).

However, an EU action on this topic would be a faster way to involve every citizen of every MS and to prevent sparse and disordered initiatives. There is still considerable technical potential to increase the efficiency of WuPs, particularly in the building sectors. There is a wide range in the water-efficiency of different products, and the price of mains water should make it cost-effective for buyers to take water-efficiency into account.

Regarding the prioritisation of WuPs, residential WuPs appear to be of highest priority as they will most likely be easiest to deal with immediately. They also have the greatest potential for improvement in savings as they are universal products used in every household and it is unlikely that they will be facing a significant downward market turn in the near future. Within this category, WCs, taps and showers are considered to be high priority products.

As certain commercial WuPs have water consumption and market patterns similar to those of their residential counterparts, it may be worth considering products of this type together. Many existing schemes and legislations appear to include the two together or under similar categories (such as WCs and taps).

As data is scarce or missing for many of the industrial WuPs, it is difficult to determine their priority in the context of all WuPs in Europe. Shifting the focus from the product level to plant level could have a greater effect, considering that specific process steps for each type of industry may also consume vast amounts of water. Further investigation would be required to determine which course of action would provide the greatest benefit in terms of overall water savings in industry.

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7. CONCLUSIONS AND RECOMMENDATIONS

7.1. CONCLUSIONS

7.1.1. EXISTING SCHEMES AND MEASURES ADDRESSING WATER EFFICIENCY

At EU level, very few pieces of legislation and policy measures introduce water efficiency requirements. Moreover, the coverage of WuPs has been very limited, mainly addressing products with significant energy consumption (such as washing machines and dishwashers), although it seems that it might change in the near future with the extension of the Ecodesign Directive to cover energy-related products, which include water-using devices.

At the national level, some initiatives exist within Europe and in third countries (e.g. Unites States, Australia) which introduce water efficiency requirements, particularly for household and commercial WuPs such as showers, dishwashers, washing machines, urinal operating mechanisms, taps and tap outlets, toilet suites and matching-set cisterns, and flow regulators.

In general, it is observed that water efficiency labelling, either in the form of a certification/endorsement or as a ranking system, is a relatively new tool but also the preferred option employed by countries to curb the growing demand for water.

Technical and test standards defined by normalisation bodies are tools to harmonise the technical specifications of products. Although they are not mandatory by themselves, regulations or voluntary schemes can rely on them. Technical and test standards generally don't specifically address the water efficiency of WuPs, they usually consider the overall performance of the products. This is understandable as effectiveness and sanitary requirements shall not be compromised by water efficiency aspects.

7.1.2. BENEFITS AND LIMITATIONS OF EXISTING SCHEMES AND MEASURES

Governments have to date made little use of regulatory approaches and seem to prefer information instruments, such as labels and certificates.

The policy literature shows that regulatory instruments are highly effective in achieving their objectives, are relatively easy to set up and provide clear and transparent procedures for affected businesses. However, one of the major disadvantages, when compared to information instruments is that they fail to create environmental awareness among the public. On the other hand, a drawback of information measures is the existence of many different labelling and certification schemes.

The majority of identified labelling and certification schemes currently in operation within and outside Europe are voluntary. This voluntary approach requires that manufacturers and suppliers have an incentive to label, e.g. the need to distinguish a new technology or highlight aspects of an existing product, which is sometime the major barrier encountered. It is often pointed out that mandatory labels and certificates provide higher incentives for manufacturers to increase the efficiency of their products, creating more competition within the market and providing more choice to the consumer.

Another important aspect regarding labelling schemes is their type (e.g. a ranking system vs. a certification system). One of the advantages of certificates is certainly the reduced efforts and costs in defining elaborate requirements and test protocols. However, the fact that only one level of efficiency exists might hamper the drive for improving product efficiency beyond this standard.

Identified schemes and programmes, especially labelling and certification schemes, tend to address multiple environmental issues, such as the Blue Angel, Nordic Swan or Energy Star; fewer initiatives target water efficiency exclusively. Whilst a multiple issue approach certainly helps to keep programme costs down by bundling human and financial resources, it might, in the case of information instruments, lack clarity for consumers.

Finally, policy measures are usually not implemented as isolated measures but as part of a mix of instruments in order to increase the intended effects. Information measures, for instance, are frequently combined with other instruments because people need to gain an awareness and knowledge of a certain problem area in order to stimulate a change in behaviours and practices. For example, product labelling schemes (information) are frequently based on MPS (regulation).

An important aspect, highlighted by some experts consulted in the framework of the study that shall be taken into consideration in the future, is the fact that in some cases, existing national and international norms are less restrictive than the ones required by voluntary schemes and programmes, therefore providing little incentive for manufacturers to adhere to the strict label requirements. This also results in the paradox that some water efficient products that apply for these specific labels conform to the operational and technical requirements established in the norms but not in terms of the flow or efficiency requirements.

7.1.3. Need for an EU approach

The recent growth in consumer demand for potable drinking water is unsustainable in the long term in the context of climate change scenarios and water scarcity foreseen in many different parts of Europe.

Most existing measures focus on a handful of WuPs, mainly in households and commercial buildings, while other products are not considered to be a priority in spite of their water performance. There is still considerable technical potential to increase the efficiency of WuPs, particularly in the building sectors.

The BAU scenario would mean that water efficiency of different WuPs will only be promoted through existing schemes in at the EU and MS level, whose scope and products coverage is still limited. With the rise of environmental consciousness, the adoption of water efficient WuPs eventually will become the norm where there is no specific regulation in this regard (e.g. in the majority of the EU). However an EU action on this topic would be a faster way to involve every citizen of every MS and to prevent sparse and disordered initiatives. Based on available information and the analysis carried out in this study, considering the possibility of introducing water efficiency requirements for different WuPs at the EU level would be recommendable.

From the different options considered to introduce water efficiency requirements at the EU level, one seems to be the most appropriate, cost-efficient and feasible from a legislative point of view, and with a significant impact in terms of water savings: to set mandatory requirements through regulation for key WuPs. In particular, the recent extension of the Ecodesign Directive to cover energy-related products provides an adequate legislative framework for setting compulsory minimum efficiency requirements for some WuPs.

The quantitative analysis suggests that the introduction of mandatory requirements through the extension of the Eco-design Directive to cover WuPs could induce the greatest savings if all products are included (19.6% reduction from EU total public supply). This would correspond to 3.2% reduction from the annual total EU abstraction**.** However, if only energy-related products are included (without considering dishwashers and washing machines), the reduction is much lower, at around 6%. This is slightly lower than the minimum reduction potential of introducing a mandatory ranking label (7 to 12.1% reduction from EU total public supply). In comparison with the latter options however, and the BAU scenario, the reduction potentials of introducing a dedicated endorsement label are considerably low (1.5% reduction from EU total public supply).

Furthermore, reducing the water consumption of energy-related products such as taps, showers and baths (as recently agreed for the extension of the Directive), can also result in an indirect reduction of energy consumption: potential reduction of the heating needs by 20% from these products. This would lead to a reduction in energy use of 18.4TWh/year. This represents savings of 0.50% of total EU primary energy supply. Reducing energy use would in turn result in yearly CO_2 savings of approximately 2.89 $MtCO_{2eq}$ if standard energy-related WuPs are replaced (excluding dishwashers and washing machines).

On the other hand, the revised Ecodesign Directive does not cover in principle other products that are not energy-related, such as toilets, which still have a significant contribution to total water consumption of buildings and a large potential for improvement. Therefore, complementary measures will have to be implemented, thus resulting in additional administrative costs.

The introduction of voluntary requirements for key WuPs through an EU labelling scheme would allow the introduction of standards which go beyond existing regulation and therefore encourage environmental 'front-runners'. Nevertheless, this option would require the development of new criteria for different existing products and new product groups to be covered. With the existence of the EU Eco-label, there is also the possibility of including WuPs as additional product groups. However, this option would need to be further analysed and studied as evidence has shown that the EU Eco-label results thus far have proven to be insufficient for washing machines and dishwashers: no washing machines have ever been awarded the Eco-label and only one dishwasher has ever received the label. .

7.2. RECOMMENDATIONS

7.2.1. RECOMMENDATIONS FOR AN EU APPROACH

1. Initially, taps, shower heads, toilets, washing machines, and dishwashers should be scheduled for study and addressed within the building sector, and cleaning equipment should be addressed within the industry sector.
2. Given the recent adoption of the extension of the Ecodesign Directive to cover energy-related products, introducing mandatory requirements through regulation seems to be the most cost- and legislative-efficient option. It will also be the most beneficial in terms of water savings.
3. A possible option to be considered would be that the regulatory framework could incorporate powers to schedule products for which implementing measures would be mandatory (those that are energy-related) and other products for which water efficiency requirements could be optional. Alternatively, for those products which are not energy-related (e.g. toilets), water requirements could be introduced through a dedicated label.
4. The technical basis of the program should be existing European and international norms and TS, although in some cases, revision is recommended and some new ones will have to be developed.
5. The Standard/s should retain the present links between the water consumption tests and the energy consumption tests for clothes washers and dishwashers.
6. Existing regulation and voluntary programmes will have to be adapted and changed in line with the new water efficiency requirements for each product group to be introduced through the mandatory implementing measures for energy-related labelling scheme for not energy-related products.
7. For those products that are not energy-related, if a label is adopted there should be a large-scale promotional program to establish and support the scheme when it is implemented.
8. Outdoor products (e.g. hoses, sprinklers, garden irrigation systems, etc.) are used in such a wide range of ways that it is difficult to envisage the development of a European standard performance tests that would allow full

comparative labelling. Therefore, the use of an endorsement scheme could be used (e.g. such as the Australian SmartWaterMark for outdoor WuPs). The criteria for endorsement should be determined by the regulator/s with the advice of an expert panel, comprising representatives of the water supply industry, the landscaping and horticultural industries,

Based on the previous analysis and prior research on environmental policy implementation, a number of factors can be identified which are important to ensuring that policies achieve their objectives. Regardless of the policy option to be considered, following successful elements should be considered:

- avoid ambiguities by clearly describing the goals and functioning of the instrument.
- combine several instruments, which are based on strategic planning and target setting and which take into account the process and different phases of innovation,
- encourage the participation of stakeholders in the design and implementation of the instrument,
- ensure the availability of sufficient financial and human resources to operate and enforce the initiative,
- specify clear compliance procedures and sanctions,
- engage in continuous and wide-spread information, education and training activities; and
- make provisions to revise, update and evaluate the initiative in order to enhance its functioning and effectiveness.

7.2.2. PRIORITISATION OF WATER-USING PRODUCTS

Household WuPs appear to be of highest priority as they will most likely be the easiest to deal with immediately. They also have the greatest potential for improvement in savings as they are universal products used in every household and it is unlikely that they will be facing a significant downward market turned in the near future. Within this category WCs, taps and showers are considered to be high priority products. As water consumption is of particular importance in this study, washing machines may also be considered. It is important to note that although remaining household products are not considered to be of highest priority, they should nevertheless be legislated for water saving, following the introduction of standards for the latter three products.

As certain commercial WuPs have water consumption and market patterns similar to those of their household counterparts, it may be worth considering products of this type together. Many existing schemes and legislations appear to include the two together or under similar categories (such as WCs and taps). Instead of differentiating by sector, these products are often categorised according to types. For example, WCs can be categorised according to the flush systems they use (e.g. dual flush, reduced flush, and interrupted flush). Other commercial products such as car washes may also be worth considering, although they are less common and should perhaps be focused on in later stages.

As data is scarce or missing for many of the industrial WuPs, it is difficult to determine their priority in the context of all WuPs in Europe. Alternatively, focusing on management practices and introducing alternative schemes, such as tax incentives, may encourage businesses to reduce their overall water consumption. Shifting the focus from the product level to plant level could have a greater effect, considering that specific process steps for each type of industry may also consume vast amounts of water. Given, however, that cleaning equipment is used universally in industry and consumption is dependent more on the cleaning job than the type of industry they are employed in, it could be worth considering them within the scope of new European water efficiency standards.

7.2.3. INTRODUCING NEW SPECIFICATIONS

In order to develop new specifications for a product category, the EC will need precise and reliable data. Of greatest importance is how to measure and verify water savings for that product, and what constitutes "good" performance. For some product categories, such data are readily available, such as in the case of WuPs in the building sector, particularly for households. This present study provides data for an exhaustive list of WuPs. Furthermore, several products have well defined test protocols and have been independently tested for efficiency and performance for a number of years, resulting in a large amount of available data (i.e. washing machines, dishwashers, toilets, etc). On the contrary, some product categories may have limited data available on testing and/or lack independent studies to demonstrate their efficiency or performance (i.e. WuPs found in the industry sector and some outdoor WuPs). Once performance attributes are defined and a protocol is identified, performance levels must be set. This process includes answering the following questions based on performance test data and/or independent studies:

- What is the existing range of product performance?
- Are there any unintended or negative impacts caused by anticipated specification requirements?

If any of these questions cannot be answered, the data is insufficient for specification development and the gap will have to be filled in. For certain product groups, the available data is still limited and in some cases, the range of water consumption varies considerably depending on the specific context (in the case of industrial water-using equipment or in the case of outdoor WuPs).

7.2.4. STUDY LIMITATIONS AND FUTURE WORK

The results of this study show that there is considerable potential to increase the efficiency of water use in Europe by changing both the consumption as well as the production pattern of WuP. However, the following limitations need to be taken into account when assessing the findings of this work:

- **Limited data on water consumption and saving potential of different WuPs**

Data detailing the consumption of different WuP is fragmented. Whilst consumption and consumption patterns are well documented for common household products, information on water usage of industrial or agricultural equipment is limited. As a result, and coupled with a lack of information on market trends for many of the investigated products, only tentative conclusions regarding their saving potential can be drawn.

- **Insufficient comparable data on policy effectiveness**

Whilst it should be possible in principle to conduct the types of assessment needed to establish data reflecting the improvements associated with different types of water efficiency measures, in practice this information is not widely available. Many policy instruments lack accompanying monitoring programmes and baseline data which could be used to establish policy instrument impacts. As a result, evaluations often rely on proxy indicators and anecdotal evidence However, these types of data are not a sufficient basis for assessing the effectiveness of policy instruments (see also *UNEP 2005 b*). Where evaluation studies are available, applied methodologies frequently vary, making it difficult to compare policy impacts in a consistent manner.

- **Policy measures were only recently introduced**

Many of the policy instruments addressed in this study were only established fairly recently. Therefore, only short-term effects might be noticeable at this point given that policy measures require a certain amount of time to achieve their intended targets. For example, given the time it takes for consumers to become familiar with and trust the information presented on a product label, it is reasonable to assume that a fair amount of time will elapse between the introduction of a labelling scheme and significant increases in the market share of efficient models (see also *Vreuls 2005*).

- **Target groups and mechanisms vary**

Following on from the point just made, it needs to be acknowledged that the instruments investigated in this study address specific target audiences and pursue different 'avenues of change'. Minimum Performance Standards, for example, are specifically aimed at manufacturers and try to prevent them from placing less efficient product models on the market. Labels on the other hand focus both on the consumer and manufacturers in an attempt to change purchasing and production patterns. Subsequently, effectiveness needs to be approached differently for different categories of instruments.

- **Causes and effects are difficult to establish**

Finally, on a more general level, the influence of a certain policy measure on the behaviours and action of the target group are difficult to ascertain. For example, manufacturers are affected by a multitude of market and regulatory pressures, technology changes or other aspects. Thus, it is difficult to establish whether changes in their product range are in reaction to a specific policy measure or simply a result of advancing technologies (*UNEP, 2005 b*).

Therefore, future research should focus on the following six areas:

- First, further research on the water performance of industrial water-using equipment as well as higher efficiency technical alternatives is needed.
- Second, the agricultural sector offers a large potential for water savings. In this regard, further research is still required particularly on possible parameters defining efficiency and allowing comparison of different irrigation system.
- Third and on a more general level, researchers are encouraged to investigate whether there are certain product types or characteristics which are associated with higher efficiency of water use (e.g. the water use and wastage of evaporative air conditioners and water heaters).
- Fourth, more detailed and specific information on market trends would be necessary for some of the WuPs (such as cooling systems used in the buildings sectors) that have been analysed in the framework of this study.
- Fifth, there is a need to begin to develop a set of assessment tools to monitor the effectiveness, benefits and costs of different types of policy measures. This would generate comparable and quantified empirical data evidencing the benefits of different policy approaches. Given that policy initiatives are still relatively young or just emerging; this presents a great opportunity to integrate monitoring programmes in the design of policy instruments. Policy makers should note, though, that different instruments investigated in this study address specific target audiences and pursue different 'avenues of change'. Minimum Performance Standards, for example, are specifically aimed at manufacturers and try to prevent them from placing less efficient product models on the market. Labels on the other hand focus both on the consumer as well as manufacturers in an attempt to change purchasing and production patterns. Subsequently, effectiveness needs to be approached differently for different categories of instruments.
- Finally, it needs to be acknowledged that the water performance of different products largely depends on usage patterns and the behaviour of water consumers. Future research should explore consumer awareness and behaviour in order to establish the extent to which water efficiency can be achieved through educational and information campaigns. Furthermore, societal attitudes also play a role in the success and appropriateness of water efficiency initiatives. These inter-linkages and their impact on the effectiveness of different policy measures could be investigated in more detail.

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9. APPENDICES

APPENDIX 1: OVERVIEW OF BASIC POLICY MEASURES AND CORRESPONDING SUB-CATEGORIES

Type of instrument	Subcategory
Regulation	Performance standards
	Building codes
Economic	Subsidies (rebates)
	Taxes, tax exemptions, tax credits
	Fees and user charges
	Reduced-interest loans
	Bulk purchasing
	Grants
	Procurement
Information	General information
	Labelling
	Certificates
	Information centres
	Audits and sustainability reporting
	Education and training (consumer advice)
	Demonstration
	Governing by example
Voluntary agreements	Unilateral commitments by industry
	Agreements between industry and public authorities
	Schemes set up by public authorities
Research and development	Research programmes
	Technology development
Cross-cutting measures	Plans, strategies etc.
Combinations	

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APPENDIX 2: FACT SHEETS OF DIFFERENT SCHEMES AT THE EU AND MEMBER STATE LEVEL

➢ **United Kingdom**

Name	Water Supply (Water Fittings) Regulations: WC Suite Performance Specifications
Type	Mandatory regulations
Coverage	National
Year	1999
Sector	Residential
Objective	To encourage the installation of water efficient products in households and offices
Products	Toilets and urinals
Requirements	**WC:** • Those delivering a single flush of 6 litres maximum or a dual-flush of 6 litres maximum and reduced flush of no greater than 2/3 of the maximum flush. • The maximum allowable flush volume for a newly installed suite from 1st January 2001 is 6 Litres (compared with the previous 7.5 litres). For replacement installations where the existing WC remains, a 7.5 litre cistern can be fitted. • Dual flushing is now permissible. Again 6 litres being the maximum full flush and 4 litres the maximum short flush. Both Syphons and now valves can be used to control the flow of water from cistern to the WC pan. Previously only the siphon or wastewater preventor was allowed. Dual flushing can be achieved with both siphons and valves. • The use of pressure flushing valves direct from the mains will be allowed for commercial premises only where a minimum of 1.2 litres per second is available and providing that the flushing system incorporates a backflow prevention arrangement. • All WC Suites, Syphons and valves need to pass the new regulators tests. **Urinals:** • Continuous flush - to use no more than 7.5 litres per bowl per hour (10 litres for a single bowl) • Flush-per-use systems - Single urinal bowls with pressure-flushing valves and a flush volume no greater than 1.5 litres. Each office urinal might serve between one and 30 male workers

Name	BMA Water Efficiency Labelling Scheme
Type	Voluntary Label
Coverage	National
Year	2007
Sector	Residential
Objective	The aim of the Scheme is to help consumers easily identify water efficient products that when installed and used correctly use less water than other products available on the market.
Products	Toilets, showerheads, taps, independent flushing cisterns, baths
Requirements	**WC Suites:** WCs complying with Class 2 of EN 997, when flushed with the Volume(s) claimed - provided the flush does not exceed 4.5 litres per single flush, or in the case of dual flush mechanisms, by an average flush not exceeding 4.5 litres - based upon a ratio of 3 short flushes to 1 full flush. **Independent Flushing Cisterns:** Flushing cisterns that comply with the requirements of Class 2 of Pr EN 14055, that deliver flush volumes which enable WC pans to comply with the requirements of Class 2 of EN 997 - provided the volumes do not exceed 4.5 litres per single flush, or in the case of dual-flushing, an average not exceeding 4.5 litres – based upon a ratio of 3 short flushes to 1 full flush. **Taps and combination tap assemblies:** All taps (including self closing and electronic types) and combination tap assemblies - for use with wash basins and bidets, that deliver no more than 6 l/min through each inlet under pressures up to and including 5 bar. In the case of combination tap assemblies, each side of the fitting shall be tested separately. *Note 1*: In the case of combination tap assemblies with both sides fully opened: • Divided outlet types - will provide a flow rate that equates to the combined flow rate • Single outlet types - are unlikely to provide a flow rate that will equate to the combine *Note 2*: In the case of taps (all types) and combination tap assemblies supplied with interchangeable outlets - compliance with the Scheme's requirements is based upon the 'as approved' specification. The manufacturer shall clarify in installation instructions whether the Scheme's criteria is invalidated if an alternative outlet is fitted e.g. Scheme compliant as approved - with aerator fitted, but approval invalidated if a flow straightener is fitted. **Shower Controls:** All shower controls that deliver not more than a nominal 13 l/min at a single showering position under pressures up to the maximum operating pressure specified by the original manufacturer - or in the case of no maximum being specified, at pressures up to and including 5 bar.

	Baths: Baths (including Whirlpools) containing not more than 80 litres, when filled to a level equating to 40% of the total volume contained when filled to the invert of the overflow fitment.

Name	Waterwise Marque
Type	Voluntary Label
Coverage	National
Year	2006
Sector	Residential and Commercial
Objective	The Marque is awarded annually to products which reduce water wastage or raise the awareness of water efficiency. This marque serves to help consumers identify the most water efficient products available on the market.
Products	Bathroom, outdoor, kitchen and plumbing products that use water
Requirements	This is a general label which is not based on specific performance criteria for individual products. To submit an entry for an opportunity to be awarded the Waterwise Marque, the product must satisfy the entry criteria below: • The product is water efficient or raises the awareness of the need for water efficiency • The product is or will be widely available on the UK market • The product performs to a high level • The product has been designed to a high level. The Marque is unlikely to be awarded to products that, despite being water efficient within their product category, are a type of product that facilitates excessive water use.

Name	Enhanced Capital Allowance Scheme
Type	Tax rebate
Coverage	National
Year	2003
Sector	Commercial and Industrial
Objective	To encourage businesses and industry to use water efficient products.
Products	Efficient Commercial Washing Machines (CIP equipment, and monitoring and control equipment), Scrubber driers, Spray Devices, Efficient Showers (aerated showerheads, auto shut-off showers, flow regulators, low flow showerheads and thermostatic controlled showers), Efficient Taps (Automatic shut off taps,

	electronic taps, low flow screw-down/lever taps and spray taps), and Efficient Toilets and Urinals (Low flush toilets retrofit WC flushing devices and urinal controls)
Requirements	**Efficient scrubber/drier floor cleaning machines:** Those that have an efficiency ≥ 60 m2/l, achieved at a floor coverage speed of 1.33m/s, and at the wash water delivery flow rate of 2 l/min, when carrying out maintenance cleaning of internal or external flooring. **Industrial steam cleaning machines:** Those that are pressurised and operate at a minimum of 4 bar, boiler pressure with a power rating of 2kW and above. **Taps, showers and toilets**: must show evidence of compliance with Part II, Section 4 of the Water Supply (Water Fittings) Regulations 1999 **Efficient commercial washing machines**: Must be a horizontal axis washing machine with an energy and wash performance equivalent to the European Energy Label rating of AA for energy consumption and wash performance respectively. The machine must also not exceed a maximum water consumption of 12 l/kg wash load

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Type	Tax rebate
Coverage	National
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Objective	To encourage businesses and industry to use water efficient products.
Products	Efficient Commercial Washing Machines (CIP equipment, and monitoring and control equipment), Scrubber driers, Spray Devices, Efficient Showers (aerated showerheads, auto shut-off showers, flow regulators, low flow showerheads and thermostatic controlled showers), Efficient Taps (Automatic shut off taps, electronic taps, low flow screw-down/lever taps and spray taps), and Efficient Toilets and Urinals (Low flush toilets retrofit WC flushing devices and urinal controls)
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	4 of the Water Supply (Water Fittings) Regulations 1999 **Efficient commercial washing machines**: Must be a horizontal axis washing machine with an energy and wash performance equivalent to the European Energy Label rating of AA for energy consumption and wash performance respectively. The machine must also not exceed a maximum water consumption of 12 l/kg wash load

- **Spain**

Name	Ordenanza de Gestión y Uso Eficiente del Agua en la Ciudad de Madrid
Type	Mandatory Regulations
Coverage	Local (Madrid)
Year	2006
Sector	Residential, Public and Commercial
Objective	To encourage the installation of water saving products in the home and encourage water saving behaviour in the public sector and other businesses.
Products	Taps, showerheads, toilets, gardening, car wash
Requirements	**Taps:** To be fitted with water saving devices and so, for a pressure of 2.45 bar, the maximum flow supplied is 6 l/min. In no case shall the flow contributed by taps exceed 10 L/min. **Showerheads**: Must include flow economizers or a similar system to reduce flow so that, for a pressure of 2.45 bar, provided the maximum flow is 10 l/min. **Toilets**: A maximum volume of 6L per flush and must have an interruption flow or dual flush system. *(All of the above applies only to new buildings)* **Gardens and parks**: Both for public or private use and of new and renovated construction must be designed and implemented so that the doses of irrigation are: a) Daily: less than 1.8 L/m2 b) Annual: m^3/hectare < 2,500 **Commercial car washing**: Shall be performed by high-pressure systems timed to ensure water consumption of less than 70 litres per vehicle or by autonomous system mobile car washing of low water consumption.

Name	Decreto 202/1998
Type	Mandatory Regulation

Coverage	Regional (Catalonia)
Year	1998
Sector	Public and Residential
Objective	To encourage the use of water saving products in buildings
Products	Toilets, taps in the bathtub, shower, bidet, washbasins and sinks
Requirements	Water saving devices must be installed in all new and renovated buildings and should include: • A recognized label that ensures water saving taps in the bathtub, shower, bidet, washbasin and sink. • A mechanism for voluntary interruption of the output of water in toilets.

Name	Distintivo de Garantía de Calidad Ambiental Catalán
Type	Voluntary Label
Coverage	Regional (Catalonia)
Year	1994 (Water-saving products and systems covered from 2004)
Sector	Residential and Commercial
Objective	To define products and water conserving systems of high environmental quality, to help consumers easily identify water efficient products.
Products	Toilets, showerheads, taps, toilet retrofit devices for water saving, flushometers and other systems that favour water savings
Requirements	**Tap and shower elements:** • Fixed and mobile showerheads: The flow must be less than 10 l/min (1 to 3 bar) or 12 l/min (3 to 5 bar) • Lavatory, bidet and sink faucets: The flow must be less than 8 l/min (1 to 3 bar) or 9 l/min (3 to 5 bar) **Flow limiters:** • Hydraulic characteristics of the shower-head flow limiters: The flow must be less than 10 l/min (1 to 3 bar) or 12 l/min (3 to 5 bar) • Hydraulic characteristics for taps: The flow must be less than 8 l/min (1 to 3 bar) or 9 l/min (3 to 5 bar) **WCs:** • The maximum volume of water for each flush is 6 liters. • The tank should incorporate a device for interrupting the flush or of a short/long pulse. • Instructions for this device should be visible in the tank. **Water Saving devices for WCs:** The water saving device must reduce flow by at

	least 20%. **Other systems that promote savings:** Savings must be at least 20%.

➢ **Italy**

Name	Ambientale al Regolamento Edilizio della Città di Avigliana - Allegato Energetico
Type	Mandatory Regulation
Coverage	Local (Avigliana)
Year	2007
Sector	Residential
Objective	To encourage the use of water saving products in buildings
Products	Toilets and taps (incl. showers but not bathtubs)
Requirements	**Toilets**: A maximum allowable blush of 6L. Must be dual flush. **Taps (incl. bathroom and shower):** Maximum allowable flow of 8 to 12 l/min

Name	Variante all' Art. 8 delle Norme Tecniche di Attuazione del P.R.G
Type	Regulation
Coverage	Local (Urbino)
Year	1997
Sector	Residential
Objective	To regulate for the introduction of water efficient products in households
Products	Toilets
Requirements	Newly installed toilets must use dual flush systems, where the larger flush may be between 5 and 8 liters and the smaller between 3 and 5 liters

Name	Regolamento Energetico Ambientale
Type	Regulation
Coverage	Regional (Sassari)
Year	2008
Sector	Residential
Objective	To encourage the use of water saving plumbing products

Products	Toilets and taps (incl. showers but not bathtubs)
Requirements	**Toilets**: A maximum allowable blush of 6L. Must be dual flush. **Taps (incl. bathroom and shower):** Maximum allowable flow of 8 l/min

- **Portugal**

Name	Regulamento geral dos sistemas públicos e prediais de distribuição de agua e de drenagem de águas residuais
Type	Regulation
Coverage	National
Year	1998
Sector	Residential
Objective	To set safety regulations for building plumbing systems
Products	Showers
Requirements	Showers must have a **minimum flow** of 9 l/min in all buildings.

Name	Certificação da Eficiência Hídrica de Produtos
Type	Voluntary Label (E to A++ rating system)
Coverage	National
Year	2008
Sector	Residential and Commercial
Objective	Aimed at promoting and guaranteeing the quality and efficiency of building installations, with particular emphasis on facilities for water and wastewater, generally referred to as water and sanitary facilities.
Products	Currently covers toilets, rating system yet to be produced for – Showerheads, taps, washing machines and flush meters (commercial toilets and urinals).

Requirements	The following table includes rating criteria for toilets under the ANQIP scheme:

Nominal volume	Type of Flush	Efficiency Category	Tolerance (maximum full flush volume)	Tolerance (minimum water saving flush volume)
4.0	Dual flush	A++	4.0 – 4.5	2.0 – 3.0
5.0	Dual flush	A+	4.5 – 5.5	3.0 – 4.0
6.0	Dual flush	A	6.0 – 6.5	3.0 – 4.0
7.0	Dual flush	B	7.0 – 7.5	3.0 – 4.0
9.0	Dual flush	C	8.5 – 9.0	3.0 – 4.5
4.0	Variable flush systems	A+	4.0 – 4.5	-
5.0	Variable flush systems	A	4.5 – 5.5	-
6.0	Variable flush systems	B	6.0 – 6.5	-
7.0	Variable flush systems	C	7.0 – 7.5	-
9.0	Variable flush systems	D	8.5 – 9.0	-
4.0	Full flow	A	4.0 – 4.5	-
5.0	Full flow	B	4.5 – 5.5	-
6.0	Full flow	C	6.0 – 6.5	-
7.0	Full flow	D	7.0 – 7.5	-
9.0	Full flow	E	8.5 – 9.0	-

- **Ireland**

Name	Building Regulations (amendment to Part G (Hygiene))
Type	Mandatory Regulation
Coverage	National
Year	2008
Sector	Residential
Objective	To encourage the installation of water efficient products in households

Products	Toilets
Requirements	Mandatory installation of dual flush toilets, both in new buildings and in existing buildings where WCs are being replaced

➢ **Germany**

Name	The Blue Angel
Type	Voluntary Label
Coverage	National
Year	1978
Sector	Residential and Commercial
Objective	To distinguish the positive environmental features of products and services.
Products	Flushing boxes, Waste-water free car wash facilities
Requirements	• The flushing box shall be equipped with devices to reduce the flushing-water volume or to interrupt the flushing pursuant to DIN 19542, para. 3.2.4. • The possibility to save water shall be appropriately indicated on the flushing box, e.g. by providing the box with an inscription or an adhesive label • The maximum flushing-water volume shall not exceed 9 litres and the minimum amount of flushing water per uninterrupted flushing shall not fall below 6 litres. The flushing boxes shall be equipped with adjusting devices which allow an adjustment of the flushing-water volume depending on the type of the closet (within the 6 l - to - 9 l range).

➢ **Nordic Countries**

Name	The Nordic Eco-label
Type	Voluntary
Coverage	International
Year	1989
Sector	Residential and Commercial
Objective	To address general environmental, quality and health criteria for a wide range of products. To encourage eco-friendly business and consumption.
Products	Washing machines, dish washers, car wash facilities

Requirements	• Dish washers must use a maximum of 1.2 litres of water per place setting in accordance with EN 50242. Taps: 2 l/min (low-flow and aerating models) • Washing machines must not consume more than 16 litres of water per kilogram of wash load (for a standard 60ºC cotton cycle) • Car wash facilities. Maximum number of liters of fresh water that may be used per washed vehicle, calculated as an annual mean, must not exceed the values specified in the tables below:

	Requirements
Denmark and Skåne in Sweden	70 liters
The other Nordic countries and the other part of Sweden	90 liters

➢ **Europe**

Name	The European Eco-label
Type	Voluntary Label
Coverage	International
Year	1993
Sector	Residential and Commercial
Objective	To encourage businesses to market products and services that are kinder to the environment and for European consumers to easily identify them.
Products	Dishwashers, washing machines
Requirements	**Washing machine:** Water consumption ≤ 12 L per kg of washload (for the same standard 60°C cotton cycle as chosen for Directive 95/12/EC). **Dishwasher:** Water consumption (in L/cycle) ≤ (0,625 x S) + 9,25 where S is the number of standard PS.

APPENDIX 3: FACT SHEETS OF DIFFERENT SCHEMES IN THIRD COUNTRIES

- **Australia**

Name	Australian WELS
Type	Mandatory Label (5-star rating system)
Coverage	National
Year	2005
Sector	Residential and Commercial (Indoor only)
Objective	To conserve water supplies by reducing water consumption, to provide information for purchasers of water-using and water-saving products, and to promote the use of efficient water-using and saving technologies
Products	Showerheads, toilets, washing machines, dishwashers, urinals, and taps
Requirements	Minimum water performance levels for WuPs: • Showerheads: 6 or 7 l/min (for a four star rated water efficient showerhead) • Taps: 2 l/min (low-flow and aerating models) • Toilets (suites, pans, cisterns, flushing devices and combinations of these): 5.5 litres per flush (The average water consumption of a dual flush cistern is taken to be the average of one full flush and four half flushes.) • Urinals (suites, urinals, urinal flushing control mechanisms and combinations of these): 1.5 litres per flush • Washing machines: 50% water-savings • Dishwashers : half the water consumption of average models Products must be registered, rated and labelled according to the requirements of the **WELS Standard AS/NZS6400:2005 Water-efficient products-Rating and labelling.** **Implementation:** The Australian Minister for the Environment and Heritage specifies products to be covered by the WELS, the standards they must meet, and other requirements. The Commonwealth Secretary is the Regulator, and is located within the Department of the Environment and Heritage. The Regulator is responsible for monitoring and enforcing the Scheme and must provide brief updates of the Scheme annually. A full review of the Scheme will be conducted after five operational years have passed. WELS inspectors are appointed by the Regulator and are responsible for determining whether a manufacturer/importer/retailer is complying with the Act

	and the regulations. Inspectors also investigate possible offences against the Act or the regulations. They may inspect WELS products; may purchase any WELS product that is available for sale; may inspect or collect written information, advertising, or any other document that is available or made available to the public; may discuss product features with any person; and may observe practices relating to the supply of products. Manufacturers must demonstrate that their product meets AS/NZS 6400:2005 requirements by submitted laboratory test reports and other relevant product certifications that show that the water consumption of the product has been tested in accordance with relevant standards. Testing must be done either at a National Association of Testing Authorities accredited laboratory, at a laboratory approved by the WELS Regulator, or in accordance with the National Appliance and Equipment Energy Efficiency Programme. A sample of the proposed WELS label for the product must also be submitted.

Name	Smart Approved WaterMark
Type	Voluntary Label
Coverage	National
Year	2004
Sector	Residential and Commercial (Outdoor only)
Objective	To assure that the public is aware and engaged in water conservation around the home. To promote products and services that help conserve water.
Products	Hose connectors, drip irrigation, rain sensors, sprinkler systems, weather based controllers, etc.
Requirements (Water performance & product standards)	Technical Expert Panel has been set up to independently assess the applications of products and services. Guideline docs available for some product groups. Applications are assessed against the following criteria: Water Saving, Fit for Purpose, Meets Regulations and Standards, & Environmentally Sustainable.

Name	The Car Wash Water Saver Rating Scheme (WRS)
Type	Voluntary Label (Rating system)
Coverage	National
Year	2004
Sector	Commercial

Objective	Reduce the volume of potable (drinkable) water used at commercial car washes by promoting efficient water use and practices.
Products	Car washes
Requirements	This scheme measures the amount of drinking water used by car wash equipment in a defined standard wash, and then rates that equipment on its water efficiency. If one site has 2 or more types of equipment, they are rated separately and the rating signs must be displayed so as to clearly identify which rating applies to each type of equipment. The rating scale is valid for at least 3 years. The rating system is based in the following figures:

Star Rating	Number of litres per wash
Non-rated	Over 200
1	151-200
2	101-150
3	71-100
4	41-70
5	Up to 40

- **New Zealand**

Name	New Zealand WELS
Type	Mandatory Label (5-star rating system)
Coverage	National
Year	2009
Sector	Residential and Commercial (Indoor only)
Objective	To conserve water supplies by reducing water consumption, to provide information for purchasers of water-using and water-saving products, and to promote the use of efficient water-using and saving technologies
Products	Showerheads, toilets, washing machines, dishwashers
Requirements	Same as for Australian WELS except: • Additional requirements for taps and showers: low pressure hot water systems are most common in New Zealand, in contrast to high pressure systems in Australia, thus star ratings for taps and showers in New

	Zealand will also feature information on efficiency at low and at high pressures. The MCA is seeking to introduce an independent New Zealand standard or to amend AS/NZS 3718 and AS/NZS 3662:2005 to allow for alternative testing procedures; • Mandatory registration not required: New Zealand will not require the registration of WuPs as is the case in Australia. Instead, New Zealand is encouraging industry to establish their own voluntary registration scheme in order to provide additional guarantee to customers; • Minimum standards for toilets and urinals will not be set.

➢ **United States**

Name	WaterSense
Type	Certification Mark
Coverage	National
Year	2006
Sector	Residential and Commercial
Objective	Encourage local water utilities, product manufacturers, and retailers to work with EPA to encourage the use of water-efficient products and practices among consumer and commercial audiences.
Products	Toilets, basin taps, and irrigation services
Requirements	Before a manufacturer may be certified for conformance to a WaterSense specification, and before the manufacturer may use the WaterSense label, the manufacturer must enter into a WaterSense partnership agreement with the EPA. Manufacturers may enter into partnership once a draft specification has been released for their product group. Under the partnership agreement manufacturers have one year to obtain certification for their product(s) and they are required to notify the EPA when products are certified to WaterSense specifications. They are also required to make available annual sales data of labelled products. WaterSense requires third-party certification of its products and services, ensuring that they comply with WaterSense's specifications. Products are certified to conform with the relevant specification by a licensed certifying body that is either accredited by the ANSI in accordance with the WaterSense product certification system, or otherwise approved for that purpose by EPA. The following table shows the coverage and status of the WaterSense label as of mid-December 2007.

Product	WaterSense specification	Labelled	Represented
Toilets	Effective flush volume ≤ 1.28 gal; solid waste removal must be ≥ 350 g	120 models	16 brands
Bathroom sink faucets	Flow rate ≤ 1.5 gal/min at 60 psi at the inlet when water is flowing, and ≥ 1.2 gal/min at 20 psi	30 models of taps, aerators, laminar flow devices, and spray devices	3 brands
Shower-heads	In development		
Washing machines	No specification		
Dish washers	No specification		
Commercial Toilets	No specification		
Commercial Faucets	1.5 gpm at 60 psi (no less than 0.8 gpm at 20 psi)[84]		
Ice Makers	Not plannified		

Name	Energy Star
Type	Certification Mark, Voluntary Label
Coverage	National
Year	1992
Sector	Residential Indoor
Objective	Energy Star Programme is a voluntary labelling scheme aiming at improving the energy efficiency of different products and equipment. It does also introduce, for certain products, water efficiency requirements.
Products	Washing machines and dishwashers

[84] Applicable to private lavatories (e.g. hotel room bathrooms)

Requirements	

Product	Current standard	Proposed standard
Residential washing machines	WF <= 8.0	As of July 1, 2009 : WF <= 7.5 As of January 1, 2011: WF <= 6.0
Commercial washing machines (family-sized)	WF <= 8.0	As of July 1, 2009 : WF <= 7.5
Automatic Commercial Ice-makers	Into effect on January 1, 2008.	Energy and water efficiency standards vary by equipment type on a sliding scale depending on harvest rate. Water cooled machines excluded from Energy Star
Pre-rinse Spray Valves		Proposed ENERGY STAR specification abandoned after standard established in EPAct 2005

➢ **Singapore**

Name	Singapore WELS
Type	Mandatory/Voluntary Label (5-star rating system)
Coverage	National
Year	2006
Sector	Residential and Commercial (Indoor)
Objective	To help consumers make informed choices and to encourage manufacturers to develop more efficient products. The desired outcome of WELS is to reduce further water consumption by increasing awareness and by encouraging the purchase of water efficient products.
Products	Voluntary WELS for taps, showerheads, dual flush low capacity flushing cisterns, urinals and urinal flush valves, and clothes washing machines. Mandatory WELS on 1 July 2009 covering taps, dual flush low capacity flushing cisterns, and urinals and urinal flush valves.
Requirements	A product is deemed to comply if it is certified or tested to meet requirements and standards by a product certification body or testing laboratory accredited by

the Singapore Accreditation Council or its Mutual Recognition Arrangement partners.

A product is deemed to comply if it is certified or tested to meet requirements and standards by a product certification body or testing laboratory accredited by the Singapore Accreditation Council or its Mutual Recognition Arrangement partners. PUB will enforce the MWELS using a team of inspectors.

The Singapore's WELS requirements are presented in the following table.

Product	**Flow rate (at 1 – 3 bars) / flush capacity requirements**		
	Good	Very good	Excellent
Shower taps & mixers	> 7 to 9 litres/min	> 5 to 7 litres/min	5 litres/min or less
Showerheads	> 7 to 9 litres/min	> 5 to 7 litres/min	5 litres/min or less
Basin taps & mixers	> 4 to 6 litres/min	> 2 to 4 litres/min	2 litres/min or less
Sink/bib taps & mixers	> 6 to 8 litres/min	> 4 to 6 litres/min	4 litres/min or less
Dual-flush low capacity flushing cisterns	> 4 to 4.5 litres (full flush) > 2.5 to 3 litres (reduced flush)	> 3.5 to 4 litres (full flush) > 2.5 to 3 litres (reduced flush)	3.5 litres or less* (full flush) 2.5 litres or less (reduced flush
Urinals & urinal flush valves	> 1 to 1.5 litres	> 0.5 to 1 litres	0.5 litres or less** or waterless urinals
Washing machines	> 12 to 15 litres/kg	> 9 to 12 litres/kg	9 litres/kg or less

Name	Singapore Green Labelling Scheme
Type	Voluntary Label
Coverage	National but both local and foreign companies may join the scheme
Year	1992
Sector	Residential
Objective	To promote green consumerism
Products	Washing Machines

Requirements	A sample of products to be certified is tested by an accredited laboratory. Adherents must apply for the label and pay a fee. The Council may at any time without notice perform inspections of the User's Product at the factory or other premises.

- **Hong Kong**

Name	Hong Kong WELS
Type	Voluntary Label
Coverage	National
Year	2009
Sector	Residential
Objective	To provide consumers the information on the levels of water consumption and efficiency ratings of plumbing fixtures and water consuming appliances to acheive actual water savings
Products	Showerheads
Requirements	Re-registration every 2 years (2009-2011). Only covers new showers imported to or manufactured in HK. Random testing of products implemented. Testing to be carried out either by an independent testing institute or self-declared by manufacturers/importers. Run by the Water Supplies Department of the Gov. Of HK Special Administrative RegionThe Department may de-register a shower from scheme in the case of non-compliance, and the shower is no longer allowed to fix a label on it. The rating system for showers under Honk Kong WELS is presented in the following table:

Nominal Water Flow Rate : f (litre/minute)	Water Efficiency Grade	Symbolic Presentation on the Water Efficiency Label
$f \leq 9.0$	Grade 1	1 water droplet
$9.0 < f \leq 12.0$	Grade 2	2 water droplets
$12.0 < f \leq 16.0$	Grade 3	3 water droplets
$f > 16.0$	Grade 4	4 water droplets

- **Korea**

Name	Korea Green Label

Type	Voluntary Label
Coverage	National
Year	1992
Sector	Residential and Commercial
Objective	To display the designated logo (Eco-Label) and brief description, in order to reduce consumption of energy and resources and to minimize generation of pollution substances in each production step.
Products	Water-saving toilets, taps, and showerheads
Requirements	Run by Korea's Ministry of Environment. Verification reports are issued by domestic testing laboratories proving compliance with the criteria. License cancellation of non-conforming product or imprisonment of up to 2 years or fine of 10 million KRW. At the bottom of the label, the reasons for certification must be displayed as specified in the Eco-Label Certificate in accordance with provisions under Article 23-2 of the Enforcement Ordinance of the Act on Environmental Technology Development & Support. Korea joined GEN in 1997, and has been an active member since.

- **Japan**

Name	Japan Eco Mark
Type	Voluntary Label
Coverage	National
Year	1989
Sector	Residential
Objective	The Eco Mark Program serves to suggest wise product choices for an ecological lifestyle and, ultimately, an environmentally sound society.
Products	Toilets and Taps
Requirements	Eco Mark program is operated by Japan Environment Association (JEA) and the administration is conducted by JEA Eco Mark Office. Certification Criteria for every product category has taken the environmen the life stage (resource extraction, manufacture, distribution, use, disposal, recycling) of products into consideration and enacted.

	Examination for product certification cannot be performed when there is no corresponding product category. Based on Certification Criteria for the corresponding product category, the Eco Mark Committee for Product Certification performs examination for product certification of the Eco Mark. When it is certified, it is required to conclude Eco Mark Utilization Contract between the applicant and the Japan Environment Association (JEA) for the every product that is subject to. It is allowed to use and display of Eco Mark to the product concerned till the expiry date indicated in the Certification Criteria concerned, from the date of conclusion of Eco Mark Contract. When something false is found on the application form or when the Eco Mark is used wrong, usage rights will be cancelled or other necessary measures will be taken. When the Eco Mark usage rights are cancelled, the contract for Eco Mark utilization is also automatically cancelled simultaneously, thus the Eco Mark cannot be used.

- **Thailand**

Name	Thailand Green Label
Type	Voluntary
Coverage	National
Year	1994
Sector	Residential and Commercial
Objective	The scheme is developed to promote the concept of resource conservation, pollution reduction, and waste management.
Products	Taps, showers, flush valves for urinals, flushing toilets, washing machines, commercial laundry machines
Requirements	TEI examines the application to ensure that it is completed and all criteria are met. TEI delivers the application to TISI for further investigation of criteria fulfilment. Finally, TEI registers the application and awards the green label by granting a contract. The applicant right to use the Green Label is conditional upon its fulfillment of the terms or the contract, which will be valid for a maximum period of two years, or until the criteria for green label status are re-evaluated.

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APPENDIX 4: BEST PRACTICE CASE STUDIES

- **MS schemes**

BMA WATER EFFICIENCY LABELLING SCHEME United Kingdom	
Type	Voluntary label
Coverage	National
Year launched	2007
Sector	Residential and commercial
Products Covered	Toilets, showerheads, taps, independent flushing cisterns and baths
ORGANISATION/IMPLEMENTATION	
Implementing Authority/ies	The Bathroom Manufacturer's Association (BMA), partnered with Kiwa.[85]
Aims and objectives	The aim of the Scheme is to help consumers easily identify water efficient products that, when installed and used correctly, use less water than other products available on the market.
Motivation for inception	Water scarcity is fast becoming an important issue in the United Kingdom, as water supplies are coming under mounting pressure. Population growth in certain region, climate change pressures and an increase in consumer demand all contribute to this effect. With the aid of the Bathroom Manufacturer's Association (BMA), manufacturers wish to aid in the effort to reduce water consumption by producing innovative products which use less water but are still able to perform according to consumer needs.
Implementation, requirements and control measures	The Scheme is open to all manufacturers of bathroom products destined for the United Kingdom. The manufacturer must demonstrate that their product meets the criteria as defined by technical experts. A third party certification body tests for scheme compliance according to criteria set out in the Guide to Testing, prepared by the BMA. An annual audit of registered products is undertaken by a third party certification body to assess for compliance by testing randomly selected registered products.
Supporting legislation and auxiliary measures	To be eligible, WC suites must comply with standards set in EN 997. Furthermore, flushing cisterns must comply with the requirements of Class 2 of Pr EN 14055. Products submitted for approval must also comply with all relevant British Regulatory requirements, most notably the United

[85] Independent qualified organization that works in certification

	Kingdom Water Supply (Water Fittings) Regulations 1999.
PROGRESS/RESULTS	
Acceptance	**By manufacturers**: Over 530 products are currently listed under the Scheme across 5 categories (WC's, independent flushing cisterns, baths, showerheads and taps). So far products have been registered by 18 companies, which include well known British brands, as well as international brands such as Ideal Standard, Roca, Laufen, Serel. So far, manufacturers have seen a growth in water efficient products; however, since its launch, market conditions have seen a downturn which has hampered the sale of such equipment within new build and refurbishment. **By retailers**: The BMA is currently in talks with major retailers to raise awareness of the Scheme and the label. Registered companies are now using the label in adverts, on the web site, on packaging, via CAD systems and encouraging retailers to take up these products. As the Scheme is relatively new, it is too early to tell whether retailers will take up more of these products. **By general public:** The Scheme is marketed to the consumer via the press. However, as the scheme was only launched recently, it is too early to tell whether the measures used so far will be successful. As the scheme is voluntary, it may require additional market push from interested parties such as Waterwise, Water Utilities, and the Environment Agency.
Additional accomplishments	N/A
Challenges and limitations	Despite being a relatively new scheme, a few issues have been noted by the BMA which will need to be overcome. One of the greatest concerns is whether such products will be sold given the current economic climate. The implementing authority has mentioned that the United Kingdom has a weaker water system pressure than the rest of Europe. Many consumers are dissatisfied with this and, in particular, opt to purchase showers that deliver a higher pressure flow, and therefore, consume a greater amount of water. It is also not uncommon for British consumers to have more than one shower a day. Consumer awareness of the label is also one challenge that must be faced. Although some are aware of energy labels which have been active for a much longer period. The authority believes that in order to overcome these challenges, manufacturers and retailers may require more incentives by government and not in the terms of more legislation, quoting the success of schemes such as those in Australia and USA. Also it is believed that the products themselves are not inadequate, but instead the problem may lie with the consumers. Consumers must be encouraged to be more water efficient – a tap is only as efficient as the

	user, for example. Education is key and should highlight the need to reduce water wastage, rather than just water use.
Future prospects	The association has recently agreed on expanding the current categories to include grey water systems, rainwater harvesting, shower handsets, and to include a rating system on volume and flow rates across the categories. The introduction of ratings and new categories is forecasted for the 1st of September 2009 once details have been determined.

ANQIP CERTIFICATION FOR PRODUCT WATER-USE EFFICIENCY

(Certificação da Eficiência Hídrica de Produtos)

Portugal

Type	Voluntary Label (E to A++ rating system)
Coverage	National
Year launched	2008
Sector	Residential and commercial
Products Covered	Toilets
ORGANISATION/IMPLEMENTATION	
Implementing Authority/ies	Associação Nacional para a Qualidade nas Instalações Prediais (ANQIP)
Aims and objectives	The scheme is aimed at promoting and guaranteeing the quality and efficiency of building installations, with particular emphasis on facilities for water and wastewater, generally referred to as water and sanitary facilities. This is achieved via several means, one of which is to encourage consumers to purchase water saving products. The label attempts to inform buyers on which products are most efficient in order to make more environmentally sound choices.
Motivation for inception	Due to economic and population growth in Portugal, water supply is experiencing increasing demand. The imminent effects of climate change are also predicted to intensify the pressure on the water supply and exacerbate scarcity issues. In Portugal the need to increase water use efficiency was recognised as a national priority through the Resolution of the Council of Ministers number 113/2005, of 30/6.
Implementation,	Scheme applies only to adherents who join as members of the association

requirements and control measures	upon signature of contract and biannual payments. To adhere to the scheme, a laboratory audit and certification is carried out assess the eligibility of the product in question. In order to qualify for the scheme, adherents must conform to regulations established by the authority. Failure to meet regulations results in suspension from the scheme.
Supporting legislation and auxiliary measures	It was via the aforementioned resolution that the National Plan for Efficient Water Use (PNUEA) was established. As well as other measures, the plan proposed the introduction of labelling as a method of increasing water use efficiency of products used solely in buildings. It was via this plan that the ANQIP authority was established and subsequently, the label was introduced. The ANQIP brand is only used by those entities that produce, install or, in the case of inspection companies, accept only products which conform to European Standards. The labelling scheme was established in compliance with the draft European Standard for WC and urinal flushing cisterns (EN 14055:2007), from which flush volume levels were derived.
PROGRESS/RESULTS	
Acceptance	As the scheme is very new, it is difficult to tell how will it has been or will be accepted. Thus far, however, approximately 60% of the WC manufacturing market has adhered to the scheme.
Additional accomplishments	N/A
Challenges and limitations	Although the scheme is new, it has already been identified that one of the potentially greatest challenges to overcome will be the lack of public awareness. This relates both to the lack of awareness with regard to water scarcity issues, as well as lack of familiarity with the label and what it is for. The scheme may be unsuccessful if consumers are unaware of the labels existence or its significance in Portugal.
Future prospects	Rating system is yet to be produced for showerheads, taps, washing machines and flush meters (commercial toilets and urinals). The PNUEA also proposes that labelling become mandatory, following an initial transition period.

THE CATALONIAN ENVIRONMENTAL QUALITY GUARANTEE LABEL

Catalonia (Spain)

Type	Voluntary label (Certification Mark)
Coverage	Regional

Year launched	1994 (Water-saving products and systems covered from 2004)
Sector	Residential and Commercial
Products Covered	Taps and shower elements, toilets, devices that save water in toilets, flow controllers, other systems that favour the saving of water (this products are part of the category “Products and systems that favour the saving of water”. In total, the label covers in total 27 categories of products and services)
ORGANISATION/IMPLEMENTATION	
Implementing Authority/ies	Generalitat de Catalunya, Departament de Medi Ambient i Habitatge
Aims and objectives	To provide consumers with better, more reliable information about the water performance of products and services and to promote the design, production, marketing, use, and consumption of products and services that fulfil certain environmental quality requirements beyond those established as compulsory under current regulations. In particular, in the case of the category covering some WuPs the objective was to help consumers to identify water efficient products and water conserving systems of high environmental quality *(Maria José Sarrias i Galcerán, 2009)*.
Motivation for inception	The region of Catalonia, with a very important touristic activity along the year, has faced water scarcity in recent years. In this context, measures to reduce water consumption and to increase awareness about the issue became a priority in the political agenda. The label started to cover WuPs in 2004. Two important manufacturers of taps where involved in the development of the criteria for this type of products *(Department of the Environment and Housing, 2008)*.
Implementation, requirements and control measures	This eco-labelling scheme was created under the Catalan Government's Decree 316/1994 of 4 November. Initially, the scope of the label was confined to guaranteeing the environmental quality of certain properties or features of products. Decree 296/1998, of 17 November, extended the scope of the label of Guarantee of Environmental Quality to services, thus completing the scheme. The scheme is managed by the Directorate General for Environmental Quality of the Department of the Environment and Housing, the Technical Panel attached to the Directorate General and made up of experts from the Department of the Environment and Housing and the Environmental Quality Council, on competent bodies in eco-labelling in Catalonia. Manufacturers with plants in Catalonia and distributors of own-brand products marketed in Catalonia, as well as service providers within Catalonia can apply for this label.

Applications, along with the relevant documents, should be submitted to the Directorate General for Environmental Quality. The Technical Panel assesses the applications, undertaking the actions and verifications it deems necessary in regard to compliance with the ecological criteria defined for the product group or service. The Environmental Quality Council validates the Panel's assessment and issues the corresponding resolution proposal.

The final awarding of the Environmental Quality Guarantee Label is carried out by a Resolution of the Director General for Environmental Quality within a maximum of 15 days as of the date of Agreement of the Environmental Quality Council. Finally, notification of the award is published in the Official Journal of the Government of Catalonia.

The products and systems have to comply with the requirements established in existing applicable norms (see below) with the exception of the functional requirements (i.e. the water performance), which is specifically defined by the label environmental criteria. Therefore, products and systems have to comply on the one hand with the technical requirements established in national and international norms and with water efficiency requirements established by the label *(Department of the Environment and Housing, 2008*; *Maria José Sarrias i Galcerán, 2009)*.

All the categories covering buildings (except households) and other services require the use of WuPs with the label in their criteria for the adjudication of the label.

The application fee is €337.85, with a reduction of 50% if the applicant is a microenterprise or SME. In accordance with Article 14 of Law 7/2004, of 16 July, there is no longer an annual fee for use of the Emblem. The renewal fee (to be paid every 3 years) is €225.25, also with a reduction of 50% in the case of SMEs. For applicants with EMAS or ISO 14001 the certification fee has a reduction of 15%. Neither the application fee nor the renewal fee cover the cost of testing or verifying applicant products and services. These costs must be met by the applicants and paid directly to the accredited verifying body. Every year, the Department of the Environment and Housing provides funding for testing *(Department of the Environment and Housing, 2008)*.

The criteria of environmental requirements to be met by the products are revised periodically. The last revision is currently under discussion and will be adopted soon.

Supporting legislation and auxiliary measures

The products and systems included in the WuPs category have to comply with the requirements established in the norm UNE 67-001-88, which regulates the test and features for several sanitary devices. In the case of flow rate regulators, their hydraulic characteristics have to be tested

	according to the EN 246:2004 norm. Different additional communication campaigns have been carried out, supporting the better knowledge of this label among users and consumers. In particular, for WuPs, the Catalan Water Agency, in conjunction with the Government of Catalonia's Department of the Environment and Housing is implementing a collaborative agreement with Ecologists in Action Catalonia in order to encourage technologies that prompt conservation and efficiency in the use of water. The aim is to create a **network of ironmongers and installers who are committed to saving water.** Individual shops, installers or groups may subscribe, provided they have water-saving mechanisms endorsed with the Government of Catalonia's emblem for the guarantee of environmental quality. Another example of campaign promoting the use of WuPs, also carried out by the Catalan Water Agency and the Department of the Environment and Housing was the Water-Saving Devices Campaign, which consisted on the distribution amongst scholars and though major newspapers in Catalonia of 650,000 sets of water-saving devices *(Catalan Water Agency 2008)*.
PROGRESS/RESULTS	
Acceptance	17 manufacturers have joined the label with a total of approximately 794 referenced products awarded with the label. The market share is still limited, although increasing progressively. It is a label recognised amongst the manufacturers, some of which participated in the elaboration of the awarding criteria from the very beginning. Also, the label has also been widely accepted by the regional administrations, who try, as much as possible to require the label in public call for tender (green public procurement).
Additional accomplishments	The prices of the products awarded with the label do not seem to be higher that in the case of their counterparts.
Challenges and limitations	For the moment, the label is still not well known among consumers and users, although different campaigns are being carried out to face this barrier for its further expansion in the market. An important limit is the fact that existing national and international norms establishing technical requirements define water requirements that are less restrictive that the ones required by the label criteria for the WuPs covered.
Future prospects	New possible WuPs are being considered for inclusion within the category "Products and systems that favour the saving of water", including water efficient car washing tunnels and commercial washing machines, for

	example.

➢ **International Schemes**

WATER EFFICIENCY LABELLING SCHEME	
Australia	
	
Type	Mandatory label
Coverage	National
Year launched	2006
Sector	Residential and commercial
Products Covered	Toilets (minimum water efficiency standards apply for toilets); clothes washing machines; dishwashers; urinals; taps; showers; and flow controllers (optional).
ORGANISATION/IMPLEMENTATION	
Implementing Authority/ies	Administered by the Australian Government (DEWHA) on behalf of all Australian governments, including a national water efficiency regulator (DEWHA Secretary).
Aims and objectives	The objectives of the scheme, as laid out in the *Water Efficiency Labelling and Standards Act 2005*, are threefold: 1) To conserve water supplies by reducing water consumption; 2) to provide information for purchasers of water-using and water-saving products; and, 3) to promote the adoption of efficient and effective water-using and water-saving technologies.
Motivation for inception	Provide for the establishment and operation of a scheme to apply national water efficiency labelling and MPS to certain WuPs. WELS primarily influences water consumption by providing consumers with information about the water efficiency of all washing machines, dishwashers, toilets, urinals, taps and showers sold in Australia – thus enabling consumers to consider water efficiency as a factor in their purchase decisions.
Implementation, requirements and control measures	The Commonwealth Secretary is the Regulator, and is located within the Department of the Environment and Heritage. The Regulator is responsible for monitoring and enforcing the Scheme and must provide brief updates of the Scheme annually. WELS inspectors are appointed by the Regulator and are responsible for determining whether a

	manufacturer/importer/retailer is complying with the Act and the regulations.
Supporting legislation and auxiliary measures	Enacted by the Commonwealth *Water Efficiency Labelling and Standards Act 2005 (WELS Act)*, supported by the AS/NZS 6400 Australian Standard, plus regulations and determination.
PROGRESS/RESULTS	
Acceptance	**By consumers and non-consumers :** Recent research suggest that the WELS Scheme is making strong inroads into both the consumer and non-consumer psyche as a common communication device or tool to assess water efficient appliances. Both consumers and non–consumers indicate high levels of unprompted awareness of energy labels (97% and 99% respectively) – suggesting that this scheme has been very successful in communicating the role of energy efficiency *(Quantum, 2008).* There are over 10,500 product models registered on WELS database. WELS is often publicized along with its sister scheme, the SmartWater Mark, which has helped raise awareness on water issues and actions consumers can take to save water.
Additional accomplishments	WELS is moving toward stronger enforcement action - in July 2007 to July 2008, there were 97 active cases, which relate mostly to advertising. In addition, WELS has demonstrated capacity to issue infringement notices penalties: $1,320 individuals; $6,600 company per offence. A study on the cost effectiveness of WELS estimated that from: • 2006 to 2021, 800 gigalitres of water will be saved. The most significant conservation potential is from showerheads (290 GL) and washing machines (280 GL), followed by toilets and urinals (185 GL). As a proportion of the overall water savings, the direct contribution to water savings due to WELS on taps and dishwashers is expected to be much smaller, constituting approximately 6% of total savings. However, wide coverage of product types could underpin the effectiveness of WELS information in driving consumer decisions about all product types. • $400 million in savings for consumers - $1 billion on water and between $380 million - $1 billion on energy (J.Chong 2008)
Challenges and limitations	Amongst consumers and non-consumers alike, many are wary of the ‘information’ provided by salespersons and consumers are more likely to ‘do their own research’ prior to visiting a store via the internet and in particular, generic search engines such as Google. To approve new product categories under WELS (i.e. outdoor WuPs), all products need standards and this is a 3 to 4 year process, so it can be a

	long and administratively cumbersome process. WELS imposes heavy costs. The WELS administrators and suppliers of WELS-related products are likely to bear the largest share of direct WELS costs. Over the period 2005-06 to 2020-21, total administration costs to the Department of Environment, Water Heritage and the Arts are projected to be about $16 million (PV 2007 dollars, 7% discount rate), including costs of staffing and various activities including promotion, enforcement, and database management.
Future prospects	The Australian Department of Environment and Heritage is currently considering an expansion of the WELS to include new products such as washer-dryers, evaporative air conditioners, instantaneous gas hot water systems, hot water re-circulators, and domestic irrigation flow controllers. Overall, the WELS activity to date appears to be producing notable benefits with the promise of further potential growth in awareness and engagement apparent through a number of avenues.

WATERSENSE United States	
Type	Certification Mark
Coverage	National
Year launched	2006
Sector	Residential and Commercial
Products Covered	Toilets, basin taps, and irrigation services
ORGANISATION/IMPLEMENTATION	
Implementing Authority/ies	US EPA
Aims and objectives	Aims to increase the adoption of water-efficient products and services by consumers and organizations.
Motivation for inception	Promotes the value of water and helps Americans make smart decisions regarding water use and WuPs.
Implementation, requirements and control measures	EPA develops specifications for water-efficient products through a public process. If a manufacturer makes a product that meets those specifications, the product is tested by a third party to ensure conformance to EPA's criteria. If it passes the test, the manufacturer is rewarded with

	the right to put the WaterSense label on that product. EPA issues specifications that set out the requirements that products and programs must meet to earn the WaterSense label.
Supporting legislation and auxiliary measures	To certify products and authorise the use of the WaterSense label, third party certifiers must be accredited by ANSI in accordance with ISO/IEC Guide 65, General requirements for bodies operating product certification systems, along with other requirements.
PROGRESS/RESULTS	
Acceptance	Nearly 300 organizations and utilities, 60 manufacturers, and 60 retailers and distributors have joined as partners thus far. To help get products on shelves and spread the word about WaterSense, EPA is recruiting partners. Many types of organizations are eligible to join as WaterSense partners. In addition to manufacturing firms, retailers, and product distributors, the program includes promotional partners who endorse and publicize the program among their constituents. Promotional partners include utilities, state and local governments, trade associations, and other non-governmental organizations. Landscape irrigation professionals who are certified by WaterSense-labeled certification programs can also become partners.
Additional accomplishments	At that time there were 22 toilets that qualified under the proposed WaterSense criteria. Once the criteria were released, 65 toilets received the WaterSense label out of an estimated 100 models that could have qualified. There are now over 120 toilet models labelled as WaterSense. Products bearing the WaterSense label are generally 20% more water-efficient than similar products in the marketplace.
Challenges and limitations	Some critics of the programme have pointed out that WaterSense labelled products cost more than standard products, which has been a big disadvantage. Also, previously, there was some bad press surrounding the promotion of high efficiency low flush toilets that did not perform well led to caution during the development of WaterSense, but overall now stakeholders, media, and consumers seem to be reacting positively to the WaterSense programme *(Market Transformation Programme (7) (2008).*
Future prospects	WaterSense might also play a role in the near future when Government sets water use criteria for new homes. WaterSense just recently released draft specifications to label water efficient new homes and flushing urinals. Specifications for showerheads and irrigation control technologies are currently under development. Finally, the EPA plans to research several options to expand product areas in the future, including additional indoor and outdoor home products, as well as commercial products.

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