ECOTAPWARE

Development of a background report for water using products (WuP) – Identification of suitable product groups

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February 2010

JRC
EUROPEAN COMMISSION

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Executive summary

The purpose of this document is to contribute to the discussion on the selection process of water-using products (WuP) for the application of the ecodesign directive. In this context, WuP can be regarded as a subgroup of energy-using products (EuP), as some of them are dependent on energy input to work as intended (e.g. high pressure cleaners). Other WuP have an impact on energy consumption during use e.g. in form of water pumping, water heating and waste water treatment (e.g. showerheads and faucets). These therefore fall in the group of energy-related products (ErP), which are covered by the recast of the ecodesign directive. Another group of WuP is not linked to energy use (e.g. toilets, urinals), and therefore does not fall under the ecodesign directive at all.

This paper aims at identifying those WuP which are the most suitable candidates for the application of the ecodesign directive. Thus, in a first step, WuP are classified. Next, an approximate analysis of environmental impacts is done on the basis of existing literature (water and energy use mainly). The environmental improvement potential of WuP is compared on the basis of existing literature.

The relevance of WuP with respect to environmental performance (water and energy use) and improvement potential in the EU-27 is shown in the following table.

During the preparation of this discussion paper, it has become clear, that there is a lack of consistent and reliable data regarding water use in different sectors. This is even more the case for information on the water use of individual products. Thus, the results of the present analysis should be considered a first estimate, and are associated with a high degree of uncertainty. However, the present paper allows identifying the water-using product groups that might be suitable for an application under the ecodesign directive.

Sector	**Water-using product**	**Legislation[a)]**		**Water and energy use**		**Improvement potential[b)]**	
		EuP/ErP	Covered	Water	Energy	Water	Energy
Agri-culture	Trickle (dripper)	Y	N	XX	n.a.	O	n.a.
	Spray (sprinklers, hose-reel, centre pivot)	Y	N	XX	n.a.	XX	n.a.
Urban	Faucet	Y	N	XX	XX	XX	XX
	Showerhead	Y	N	XX	X	XX	X
	Bathtub	Y	N	XX	X	--	--
	Bidet	Y	N	-	-	-	-
	Swimming pool	Y	N	--	--	--	--
	Fire sprinkler	Y	N	-	-	--	--
Industry	Open once-through cooling system	Y	Y[d)]	XX in total, all cooling systems aggregated	n.a.	XX in total, all cooling systems aggregated	n.a.
	Open recirculating cooling system	Y	Y[d)]				
	Closed circuit wet cooling system	Y	Y[d)]				
	Open hybrid cooling	Y	Y[d)]				
	Closed hybrid cooling	Y	Y[d)]				
	Firetube boiler	Y	Y[d)]	X in total, all boiler systems aggregated	n.a.	X in total, all boiler systems aggregated	n.a.
	Watertube boiler	Y	Y[d)]				
	Vapour generating boiler	Y	Y[d)]				
	Superheated water boiler	Y	Y[d)]				
	Process-water chemicals	n.a.	Y[d)]	X	n.a.	O	n.a.
	Process-water coke and refinery	n.a.	Y[d)]	-	n.a.	--	n.a.

Sector	Water-using product	Legislation[a)]		Water and energy use		Improvement potential[b)]	
		EuP/ErP	Covered	Water	Energy	Water	Energy
	Process-water pulp and paper, printing	n.a.	Y[d)]	XX	n.a.	O	n.a.
	Process-water metal fabrication and processing	n.a.	Y[d)]	O	n.a.	--	n.a.
	Process-water food	n.a.	Y[d)]	X	n.a.	-	n.a.
	Process-water textiles	n.a.	Y[d)]	X	n.a.	-	n.a.
	Process-water other sectors	n.a.	n.a.	X	n.a.	O	n.a.
	Fire sprinkler	Y	N	-	--	--	--
	Other	n.a.	n.a.	X	n.a.	O	n.a.
Hori-zontal	High-pressure & steam cleaner	Y	N	O	-	-	-
	Car-wash facilities	Y	N	-	--	--	-

a) *Legend: Y: yes. N: no; b) technical potential as opposed to technological change (e.g. switching from on irrigation system to another or replacing bathing by showering) or behavioural changes (e.g. taking a shower less often); c) covered by EuP implementing measure; d) covered by other legislation, e.g. BREF documents; e) n.a.: not analysed; f) assuming a reduction potential of 20 %

Greatest water use in products can be found in urban WuP (faucet, showerhead, and bathtub) and agricultural WuP (e.g. sprinklers). WuP for cooling in industry show high water use in total, however, this has to be disaggregated to the individual WuP; a task that could not been done within this analysis. Also, industrial water use by boilers is high in total. For individual industry sectors, water use is relatively high (e.g. pulp and paper). Again, a disaggregation to individual WuP could not be done in the context of this discussion paper. From the perspective of water and energy use, horizontal technologies as high-pressure & steam cleaning or car-washing are almost irrelevant.

If we look at the water saving potential, the ranking is as follows: highest saving potential is due to irrigation by sprayers (sprinklers, hose-reel, and centre pivot), faucets, and showerheads. Also, industrial cooling shows a high reduction potential. However, with respect to agriculture, there seem to be measures that lead to a higher saving potential compared to technological improvements of individual irrigation products, e.g. improved irrigation management, optimised mix of existing technologies or a comprehensive pricing scheme (see Table 9). These measures would probably generate less administrative cost and burden to farmers than the development of implementing measures. In industrial applications, apparently, water efficiency is already high, especially in industries that show high water use, as water as a cost factor is already taken into account in process efficiency improvements. In addition, the industry sectors that use most water are already covered by BREF documents which address water use.

To conclude, we would suggest the following WuP product group as the most suitable candidates for the application of the ecodesign directive:

- faucets;
- showerheads.

As an alternative, they could be analysed together in one product group „sanitary tapware" which would include the two products faucets and showerheads. A second product group would then still to be defined. To this end, further discussion is needed, complemented with a more in-depth analysis of water using products in the different sectors.

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1 Preface

This document is meant to be a contribution to further discussion in the selection process of water-using products (WuP) for the application of the ecodesign directive. The analysis is based on literature research. Empirical data regarding water use of products in the different sectors is scarce. The information found is not harmonised and in some cases contradictory. That is true for quantities of water used and, related to this, for behavioural issues; i.e. how and how often are the individual products used. As a result, the results provided in this document have a certain degree of inconsistency and variability. However, for the purpose of identifying and proposing water-using products for further and detailed analysis in the ecodesign preparatory studies no exact quantifications are needed, but sufficiently reliable information which allows to conclude where the highest improvement potential in terms of water and energy saving can be found. This discussion paper aims at providing this kind of information.

2 Background

In 2005, the ecodesign of energy-using products directive 2005/32/EC entered into force [1]. In 2009, the directive 2009/125/EC extended the scope to energy-related products [2]. The ecodesign directive is a framework directive which does identify neither specific products nor minimum performance requirements. It describes the conditions and procedures for developing minimum requirements, which are then laid down in implementing measures for individual products in comitology procedure. The aim of the directive is to identify through a life cycle approach the environmental performance of energy-using respectively energy-related products as well as the potential to reduce their environmental impacts and to derive minimum energy efficiency requirements for these products. These are developed into implementing measures which are mandatory for these products when placed on the Community market (EU-27 plus EEA).

In the working plan 2009-2011 COM(2008)660 a number of product groups have been identified for the application of the ecodesign directive, amongst them the group of water-using products [3]. Water-using products (WuP) can be addressed in this context as a subgroup of energy-using products (EuP), as some of them need energy to work as intended, such as for example high pressure cleaners. Other WuP such as e.g. bathroom products (showerheads and faucets) have an impact on energy consumption during use e.g. in form of water pumping, water heating and waste water treatment. These therefore fall in the group of energy-related products (ErP), which are covered by the recast of the ecodesign directive 2009/125/EC which has been adopted on 21 October 2009. Another group of WuP is not linked to energy consumption during use, such as toilet flush, and therefore does not fall under the ecodesign directive at all.

The selection of water-using products for application under the ecodesign directive is hampered by two main drawbacks. Firstly, WuP are not a homogeneous group of products which is commonly agreed on. Secondly, few studies have been carried out analysing the environmental performance of WuP. For water abstraction and water consumption of products information is scarce, and consequently for the consumption of energy during the use phase few data sources exist. For above reasons it is difficult to identify which products in this group are the most suitable candidates for the development of environmental minimum requirements. As a preparation for the development of implementing measures for WuP, it is necessary to carry out an overview of existing research in the

area of WuP and their environmental performance, and to carry out an approximate analysis in order to identify those products with the highest environmental improvement potential both at product level and at the aggregated level of EU-27 when taking into account overall consumption in EU-27. This will be addressed in the present document.

3 Objective

Having in mind the above mentioned limitations the following analysis identifies those water-using products (WuP) which are most suitable candidates for the application of the ecodesign directive.

More specifically the methodology used is structured as follows:

1) Identification and classification of WuP. If possible, classification is done according to existing classification systems. If no adequate classification exists, a suitable proposal for a classification will be developed.
2) A first approximate analysis of environmental impacts is done on the basis of existing literature (water use and energy use mainly).
3) The environmental improvement potential of different WuP is compared on the basis of existing literature.
4) A ranked list of WuP will be presented.

4 Overview and classification of water-using products

For the definition of water-using products (WuP) we follow BIOIS: “a WuP is defined as a product that uses water to fulfil its intended basic function” [4]. WuP have been discussed in several studies that were prepared on behalf of DG ENV [4,5]. In general, these studies classify WuP first according to the sector (agriculture, industry, buildings). Table 1 provides an overview over the main product groups and water-using products according to sector.

Table 1 Overview over main WuP according to sector and product group

Sector	Product group	Water-using product
Agriculture	Irrigation systems	Trickle (dripper)
		Spray (sprinklers, hose-reel, centre pivot)
		Surface flow (furrow, border)
	Cleaning equipment	High-pressure & steam cleaner
Urban	Sanitary tapware	Faucet
		Showerhead
	Sanitary ware	Bathtub
		Toilet
		Urinal
		Bidet
	Outdoor use	Swimming pool
		Sprinkler
	Heating & hot water	Water heater
		Central heating boiler

Sector	Product group	Water-using product
		Central heating combi boiler
	Cooling	Evaporative air cooler
	Cleaning equipment	High-pressure & steam cleaner
	Household appliances	Washing machine
		Dishwasher
	Other	Fire sprinkler
Industry	Cooling	Open once-through cooling system
		Open recirculating cooling system
		Closed circuit wet cooling system
		Open hybrid cooling
		Closed hybrid cooling
	Heating, hot water & steam	Water heater
		Central heating boiler
		Central heating combi boiler
		Firetube boiler
		Watertube boiler
		Vapour generating boiler
		Superheated water boiler
	Process-related WuP	Chemicals
		Coke and refinery
		Pulp and paper, printing
		Metal fabrication and processing
		Food
		Textiles
		Other sectors
	Other	Fire sprinkler
		High-pressure & steam cleaner
		Other WuP

Several commonly used product classifications are available from Eurostat which cover these WuP groups [6]: the Combined Nomenclature (CN) 2009, the PRODCOM list 2009, and the CPA 2008 (Classification of Products by Activity).

In general, not all WuP can be found in these classifications. Especially irrigation products, cleaning equipment (e.g. high-pressure cleaners), fire services (fire sprinklers), and process-related WuP are often not covered or covered only in a much aggregated way. In general, also sanitary tapware is included only at aggregated level. The following tables show the WuP included in the respective classifications. Generally speaking, the CN 2009 classification (Table 4) is the classification that shows the highest details, followed by the PRODCOM List 2009 (Table 2) and the CPA 2008 classification (Table 3).

Table 2 WuP in the PRODCOM List 2009

Code	Description
22.23.12.50	Plastic baths, shower-baths, sinks and wash-basins
22.23.12.70	Plastic lavatory seats and covers
22.23.12.90	Plastic bidets, lavatory pans, flushing cisterns and similar sanitary ware (excluding baths, showers-baths, sinks and wash-basins, lavatory seats and covers)
22.29.23.90	Other toiletry and household articles of plastics n.e.c.

Code	Description
23.42.10.30	Ceramic sinks, etc and other sanitary fixtures, of porcelain or china
23.42.10.50	Ceramic sinks, wash basins, baths… and other sanitary fixtures, n.e.c.
25.21.11.00	Radiators for central heating, not electrically heated, and parts thereof, of iron or steel
25.21.12.00	Boilers for central heating other than those of HS 84.02
25.30.11.10	Watertube boilers (excluding central heating hot water boilers capable of producing low pressure steam)
25.30.11.50	Vapour generating boilers (including hybrid boilers) (excluding central heating hot water boilers capable of producing low pressure steam, watertube boilers)
25.30.11.70	Super-heated water boilers (excluding central heating hot water boilers capable of producing low pressure steam)
25.99.11.10	Stainless steel sinks and wash basins
25.99.11.27	Baths of iron or steel
25.99.11.31	Sanitary ware and parts of sanitary ware of iron or steel
25.99.11.35	Sanitary ware and parts thereof of copper
25.99.11.37	Sanitary ware and parts thereof of aluminium
27.51.12.00	Household dishwashing machines
27.51.13.00	Cloth washing and drying machines, of the household type
27.51.24.90	Electro-thermic appliances, for domestic use (excluding hairdressing appliances and hand dryers, space-heating and soil-heating apparatus, water heaters, immersion heaters, smoothing irons, microwave ovens, ovens, cookers, cooking plates, boiling rings, grillers, roasters, coffee makers, tea makers and toasters)
28.14.12.33	Mixing valves for sinks, wash basins, bidets, water cisterns etc excluding valves for pressure-reducing or oleohydraulic/pneumatic power transmissions, check valves, safety/relief valves
28.14.12.35	Taps, cocks and valves for sinks, wash basins, bidets, water cisterns etc excluding valves for pressure-reducing/oleohydraulic transmissions, check, safety, relief and mixing valves
28.25.12.20	Window or wall air conditioning systems, self-contained or split-systems
28.25.12.70	Air conditioning machines not containing a refrigeration unit; central station air handling units; vav boxes and terminals, constant volume units and fan coil units
28.29.21.20	Machinery for cleaning or drying bottles or other containers
28.29.22.10	Fire extinguishers
28.29.22.20	Spray guns and similar appliances
28.29.22.30	Steam or sand blasting machines and similar jet-projecting machines (excluding fire extinguishers, spray guns and similar appliances)
28.29.60.30	Cooling towers and similar plant for direct cooling by means of recirculated water
28.30.60.10	Agricultural or horticultural watering appliances
28.94.22.30	Household or laundry-type washing machines of a dry linen capacity > 10 kg (including machines that both wash and dry)

Table 3 WuP in the CPA 2008

Code	Description
22.23.12.50	Plastic baths, shower-baths, sinks and wash-basins
22.23.12.70	Plastic lavatory seats and covers
22.23.12.90	Plastic bidets, lavatory pans, flushing cisterns and similar sanitary ware (excluding baths, showers-baths, sinks and wash-basins, lavatory seats and covers)
23.42.10.30	Ceramic sinks, etc and other sanitary fixtures, of porcelain or china
23.42.10.50	Ceramic sinks, wash basins, baths... and other sanitary fixtures, n.e.c.
25.21.11.00	Radiators for central heating, not electrically heated, and parts thereof, of iron or steel
25.21.12.00	Central heating boilers, for producing hot water or low pressure steam (other than HS 84.02)
25.30.11.10	Watertube boilers (excluding central heating hot water boilers capable of producing low pressure steam)

Code	Description
25.30.11.50	Vapour generating boilers (including hybrid boilers) (excluding central heating hot water boilers capable of producing low pressure steam, watertube boilers)
25.30.11.70	Super-heated water boilers (excluding central heating hot water boilers capable of producing low pressure steam)
25.99.11.10	Stainless steel sinks and wash basins
25.99.11.27	Baths of iron or steel
25.99.11.31	Sanitary ware and parts of sanitary ware of iron or steel
25.99.11.35	Sanitary ware and parts thereof of copper
25.99.11.37	Sanitary ware and parts thereof of aluminium
27.51.12.00	Household dishwashing machines
27.51.13.00	Cloth washing and drying machines, of the household type
28.11.21.30	Steam turbines and other vapour turbines (excluding for electricity generation)
28.11.21.50	Steam turbines for electricity generation
28.11.23.00	Gas turbines (excluding turbojets and turboprops)
28.14.11.20	Pressure-reducing valves of cast iron or steel, for pipes, boiler shells, tanks, vats and the like (excluding those combined with lubricators or filters)
28.14.11.40	Pressure-reducing valves for pipes, boiler shells, tanks, vats and the like (excluding of cast iron or steel, those combined with filters or lubricators)
28.14.12.33	Mixing valves for sinks, wash basins, bidets, water cisterns etc excluding valves for pressure-reducing or oleohydraulic/pneumatic power transmissions, check valves, safety/relief valves
28.14.12.35	Taps, cocks and valves for sinks, wash basins, bidets, water cisterns etc excluding valves for pressure-reducing/oleohydraulic transmissions, check, safety, relief and mixing valves
28.14.12.53	Central heating radiator thermostatic valves
28.14.12.55	Central heating radiator valves, other
28.29.22.10	Fire extinguishers
28.29.22.20	Spray guns and similar appliances
28.29.22.30	Steam or sand blasting machines and similar jet-projecting machines (excluding fire extinguishers, spray guns and similar appliances)
28.29.22.40	Other mechanical appliances for projecting, dispersing or spraying
28.29.50.00	Non-domestic dish-washing machines
28.30.60.10	Agricultural or horticultural watering appliances
28.94.21.50	Washing, bleaching or dyeing machines (including wringers and mangles, shaker-tumblers; excluding household or laundry-type washing machines)
28.94.21.80	Machines used in the manufacture of linoleum or other floor coverings for applying the paste to the base fabric or other support; machines for dressing, finishing, wringing, drying, coating or impregnating textile yarns, fabrics or made up textile articles
28.94.22.30	Household or laundry-type washing machines of a dry linen capacity > 10 kg (including machines that both wash and dry)
28.95.11.13	Machinery for making pulp of fibrous cellulosic material
32.30.15.00	Other articles and equipment for sports or outdoor games; swimming pools and paddling pools

Table 4 WuP in the Combined Nomenclature 2009

Code	Description
39.22.10.00	Baths, shower-baths, sinks and washbasins, of plastics
39.22.20.00	Lavatory seats and covers, of plastics
39.22.90.00	Bidets, lavatory pans, flushing cisterns and similar sanitary ware, of plastics (excl. baths, shower-baths, sinks, washbasins, lavatory seats and covers)
69.10.10.00	Ceramic sinks, washbasins, washbasin pedestals, baths, bidets, water closet pans, flushing cisterns, urinals and similar sanitary fixtures of porcelain or china (excl. soap dishes, sponge holders, tooth-brush holders, towel hooks and toilet paper holders)

Code	Description
69.10.90.00	Ceramic sinks, washbasins, washbasin pedestals, baths, bidets, water closet pans, flushing cisterns, urinals and similar sanitary fixtures (excl. of porcelain or china, soap dishes, sponge holders, tooth-brush holders, towel hooks and toilet paper holders)
73.24.10.00	Sinks and washbasins, of stainless steel
73.24.21.00	Baths of cast iron, whether or not enamelled
73.24.29.00	Baths of steel sheet
73.24.90.00	Sanitary ware, incl. parts thereof (excl. cans, boxes and similar containers of heading 7310, small wall cabinets for medical supplies or toiletries and other furniture of chapter 94, and fittings, complete sinks and washbasins, of stainless steel, complete baths and fittings)
74.18.00.00	Table, kitchen or other household articles, sanitary ware, and parts thereof, of copper; pot scourers and scouring or polishing pads, gloves and the like, of copper (excl. cans, boxes and similar containers of heading 7419, articles of the nature of a work implement, articles of cutlery, spoons, ladles, etc., ornamental articles, fittings)
76.15.00.00	Table, kitchen or other household articles, sanitary ware, and parts thereof, of aluminium, pot scourers and scouring or polishing pads, gloves and the like, of aluminium (excl. cans, boxes and similar containers of heading 7612, articles of the nature of a work implement, spoons, ladles, forks and other articles of heading 8211 to 8215, ornamental articles and fittings)
76.15.20.00	Sanitary ware and parts thereof, of aluminium (excl. cans, boxes and similar containers of heading 7612, and fittings)
84.02.11.00	Watertube boilers with a steam production > 45 t/hour
84.02.12.00	Watertube boilers with a steam production <= 45 t/hour (excl. central heating hot water boilers capable also of producing low pressure steam)
84.02.19.10	Firetube boilers (excl. central heating hot water boilers capable also of producing low pressure steam)
84.02.19.90	Vapour generating boilers, incl. hybrid boilers (excl. watertube boilers, firetube boilers and central heating hot water boilers capable also of producing low pressure steam)
84.02.20.00	Superheated water boilers
84.03.10.10	Central heating boilers of cast iron (excl. vapour generating boilers and superheated water boilers of heading 8402)
84.03.10.90	Central heating boilers, non-electric, of materials other than cast iron (excl. vapour generating boilers and superheated water boilers of heading 8402)
84.15.10.10	Window or wall air conditioning machines, self-contained
84.15.10.90	Window or wall air conditioning machines split-system""
84.19.11.00	Instantaneous gas water heaters (excl. boilers or water heaters for central heating)
84.19.19.00	Instantaneous or storage water heaters, non-electric (excl. instantaneous gas water heaters and boilers or water heaters for central heating)
84.19.89.10	Cooling towers and similar plant for direct cooling (without a separating wall) by means of recirculated water
84.22.11.00	Dishwashing machines of the household type
84.22.19.00	Dishwashing machines (excl. those of the household type)
84.22.20.00	Machinery for cleaning or drying bottles or other containers (excl. dishwashing machines)
84.24.30.01	Water cleaning appliances with built-in motor, with heating device
84.24.30.05	Water cleaning appliances with built-in motor, without heating device, of an engine power <= 7,5 kW
84.24.30.09	Water cleaning appliances with built-in motor, without heating device, of an engine power >= 7,5 kW
84.24.30.10	Steam or sand blasting machines and similar jet projecting machines, compressed air operated
84.24.30.90	Steam or sand blasting machines and similar jet projecting machines (excl. compressed air operated and water cleaning appliances with built-in motor and appliances for cleaning special containers)
84.24.81.10	Agricultural or horticultural watering appliances, whether or not hand-operated
84.24.90.00	Parts of fire extinguishers, spray guns and similar appliances, steam or sand blasting machines and similar jet projecting machines and machinery and apparatus for projecting, dispersing or spraying liquids or powders, n.e.s.
84.50.11.11	Fully-automatic household or laundry-type front-loading washing machines, of a dry linen capacity <= 6 kg
84.50.11.19	Fully-automatic household or laundry-type top-loading washing machines, of a dry linen capacity <= 6 kg

Code	Description
84.50.11.90	Fully-automatic household or laundry-type washing machines, of a dry linen capacity > 6 kg but <= 10 kg
84.50.12.00	Household or laundry-type washing machines, with built-in centrifugal drier (excl. fully-automatic machines)
84.50.19.00	Household or laundry-type washing machines, of a dry linen capacity <= 6 kg (excl. fully-automatic machines and washing machines with built-in centrifugal drier)
84.50.20.00	Laundry-type washing machines, of a dry linen capacity > 10 kg
84.51.40.00	Machines for washing, bleaching or dyeing textile yarns, fabrics or made-up textile articles (excl. household or laundry-type washing machines)
84.81.00.00	Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats or the like, incl. pressure-reducing valves and thermostatically controlled valves; parts thereof
84.81.80.00	Appliances for pipes, boiler shells, tanks, vats or the like (excl. pressure-reducing valves, valves for the control of pneumatic power transmission, check "non-return" valves and safety or relief valves)
84.81.80.11	Mixing valves for sinks, washbasins, bidets, water cisterns, baths and similar fixtures
84.81.80.19	Taps, cocks and valves for sinks, washbasins, bidets, water cisterns, baths and similar fixtures (excl. mixing valves)
84.81.80.31	Thermostatic valves for central heating radiators
84.81.80.51	Temperature regulators (excl. thermostatic valves for central heating radiators)
85.16.10.11	Electric instantaneous water heaters
85.16.10.19	Electric water heaters (excl. instantaneous water heaters and immersion heaters)
85.16.10.90	Electric immersion heaters
95.06.99.90	Articles and equipment for sport and outdoor games n.e.s; swimming and paddling pools

The coverage of the identified WuP by the different classifications is shown in Table 5. Only few products appear as a single category in the classifications (e.g. irrigation equipment, washing machines, dishwashers). The majority of WuP can be found in aggregated categories. For example, toilets, urinals, and bidets are usually grouped together. Also, faucets do not appear as a single category. Several WuP were not mentioned in the classifications, as it is the case for showerheads. The most disaggregated classification with respect to WuP is the CN classification.

Table 5 WuP coverage in the different classifications

Product group	Water-using product	PRODCOM	CN	CPA
Irrigation systems	Trickle (dripper)	O	O	O
	Spray (sprinklers, hose-reel, centre pivot)	O	O	O
	Surface flow (furrow, border)	O	O	O
Sanitary tapware	Faucet	O	X	O
	Showerhead	---	---	---
Sanitary ware	Bathtub	X	X	X
	Toilet	O	O	O
	Urinal	O	O	O
	Bidet	O	O	O
Outdoor use	Swimming pool	O	O	O
	Sprinkler	---	---	---
Household appliances	Washing machine	X	X	X
	Dishwasher	X	X	X
Cooling	Evaporative air cooler	O	X	---
	Open once-through cooling system	O	O	O
	Open recirculating cooling system	O	O	O
	Closed circuit wet cooling system	O	O	O
	Open hybrid cooling	O	O	O

Product group	Water-using product	PRODCOM	CN	CPA
	Closed hybrid cooling	O	O	O
Heating, hot water & steam	Water heater	X	X	X
	Central heating boiler	X	X	X
	Central heating combi boiler	X	X	X
	Firetube boiler	---	X	O
	Watertube boiler	X	X	X
	Vapour generating boiler	X	X	X
	Superheated water boiler	X	X	X
Process-related WuP	Chemicals	O	O	O
	Coke and refinery	O	O	O
	Pulp and paper, printing	O	O	O
	Metal fabrication and processing	O	O	O
	Food	O	O	O
	Textiles	O	O	O
	Other sectors	n.a.	n.a.	n.a.
Other	Fire sprinkler	O	O	O
	Other WuP	n.a.	n.a.	n.a.
Cleaning equipment	High-pressure & steam cleaner	O	X	O

X	single category
O	aggregated with other items
---	not included/not mentioned

Another way of classifying WuP is to distinguish between WuP that fall also into EuP or ErP. As mentioned earlier, there are also WuP that do not use energy at all or that are not energy-related products (Table 6). Sometimes it is difficult to distinguish between EuP and ErP. For example, cleaning equipment can be energy-using products (e.g. electric steam cleaners) or energy-related products.

Table 6 Overview over main WuP groups according to energy use

Energy-using product	Energy-related product	Non-EuP & Non-ErP
Washing machine	Trickle (dripper)	Toilet
Dishwasher	Spray (sprinklers, hose-reel, centre pivot)	Urinal
Evaporative air cooler	Faucet	Fire sprinkler
Open once-through cooling system	Showerhead	Sprinkler (garden irrigation)
Open recirculating cooling system	Bathtub	Surface flow (furrow, border)
Closed circuit wet cooling system	Bidet	
Open hybrid cooling	Swimming pool	
Closed hybrid cooling		
Water heater		
Central heating boiler		
Central heating combi boiler		
Firetube boiler		
Watertube boiler		
Vapour generating boiler		
Superheated water boiler		
High-pressure & steam cleaner		

5 Environmental performance and improvement potential

In the EU-27, around 247 km^3 of water are abstracted yearly [5]. On average, 44 % is used for energy production (mainly cooling), 24 % for agriculture, 17 % for urban use, which includes commercial and private household use, and 15 % for industry (Figure 1). Other literature sources give other figures, for example, according to [7], about 290 km^3 of water are abstracted. The shares are given with 44 % for energy, 24 % for agriculture, 21 % for public water supply, and 11 % for industry [7].

Relative figures differ largely between different countries. For example, the use of abstracted freshwater for agriculture amounts to 65 % in Spain, but only to 3 % in the UK [8].

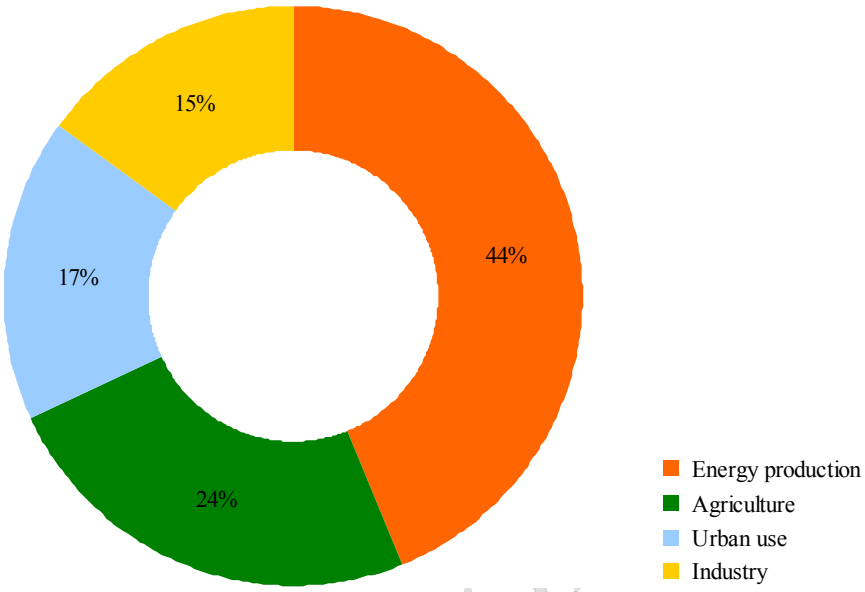

Figure 1 Sectoral share of water use in the EU-27
Source: [5]

On the basis of the identification and classification of water-using products in Table 5, in the following, the sectors agriculture, industry, public use/urban demand, and horizontal products (which are used in all sectors similarly) are analysed from the perspective of the eligibility of the individual products for the application of the ecodesign directive. This includes a look at the actual water consumption, the related energy use and environmental impacts, and the potential for the environmental improvement of the products. As a result, those products which are not in the scope of the ecodesign directive will be discarded, and the remaining products will be ranked on basis of their environmental performance.

5.1 Water-using products in the agricultural sector

Water use in the agricultural sector is driven by irrigation and cleaning equipment. Cleaning equipment, which constitutes a very minor part of agricultural water use, will be addressed in the section on 'horizontal products' (Section 5.4).

Irrigation is by far the most water consuming activity in agriculture. In Europe, 44 % of the territory is utilised as agricultural area [5]. Only part of this land is irrigated (Table 7). On average, around

9 % of used agricultural areas are irrigated in the EU-27. However, differences exist between individual countries, mainly due to climatic variation between European regions.

Table 7 Utilised Agricultural Area and Irrigated Area

Country	Irrigated Area IA (1 000ha)	Utilised Agricultural Area UAA (1 000 ha)	Relation IA / UAA in %
Austria	4	3 390	0.1
Belgium	40	1 544	2.6
Bulgaria	800	6 251	12.8
Cyprus	40	117	34.2
Czech Republic	24	4 278	0.6
Denmark	447	2 676	16.7
Estonia	4	890	0.4
Finland	64	2 219	2.9
France	2 600	29 631	8.8
Germany	485	17 033	2.8
Greece	1 431	8 502	16.8
Hungary	230	5 865	3.9
Italy	2 700	15 355	17.6
Latvia	20	2 480	0.8
Lithuania	7	3 487	0.2
Malta	2	10	20.0
Netherlands	565	1 931	29.3
Poland	100	18 392	0.5
Portugal	650	4 142	15.7
Romania	3 081	14 852	20.7
Slovakia	183	2 450	7.5
Slovenia	3	510	0.6
Spain	3 020	16 174	18.7
Sweden	115	3 144	3.7
United Kingdom	108	16 984	0.6
Total	**16 723**	**182 307**	**9.2**

Source: [5]

Precipitation is an important source of natural irrigation. It varies widely across Europe and ranges from a maximum of 1000 mm/a on the Spanish/French atlantic shores and in the alps to less than 400 mm/a in the Mediterranean regions. In some parts of southern Europe rainfall is lower than 50 mm/a. Consequently the distribution and use of irrigation equipment follows a reverse pattern.

Less than 5 % of used agricultural area is irrigated in Austria, Belgium, Czech Republic, Estonia, Finland, Germany, Hungary and Latvia, Lithuania, Poland, Slovenia, Sweden and UK. More than 10 % of used agricultural area is irrigated in Bulgaria, Cyprus, Denmark, Greece, Italy, Netherlands, Portugal, Romania and Spain. Denmark and Netherlands have only a share of 5 % in the used agricultural area in this country group, which therefore can be categorised as “Southern European countries”. This corresponds with figures from the European Environment Agency analysing the regional water abstraction in agriculture in Europe (Figure 2, data only available for EU-15).

In northern European countries the area equipped for irrigation is usually larger than the irrigated area. The surplus irrigation equipment is maintained as backup technology to be able to compensate climatic variations. In other words that means that not the full capacity of available irrigation

equipment is used in these countries. In southern Europe on the contrary, usually all available irrigation infrastructure is used due to the reliable dry climate.

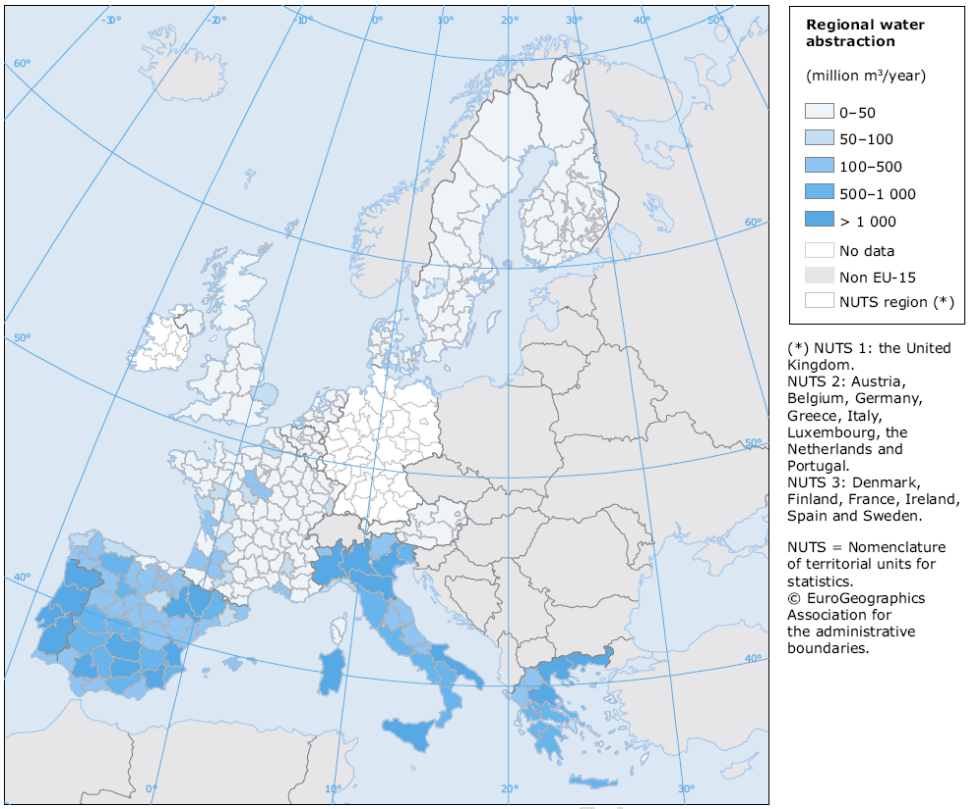

Figure 2 Regional water abstraction in agriculture in 2000
Source: [9]

There are not only differences between irrigation quantities between European countries, but also concerning the irrigation techniques (Table 8). Southern and European countries and Poland have a very high share in surface flow irrigation, whereas all other European countries show a very high share of spray technologies for irrigation.

The irrigation technologies have different field application efficiency (FAE) which is here understood as the ratio between the water used by a crop and the total amount of water delivered to that crop [7].

While surface flow has a 55 % field application efficiency, spray irrigation reaches 75 % and trickle irrigation even 90 % efficiency. That is also confirmed by a FAO report [10]. Table 8 shows the share of application of the different irrigation technologies across Europe and the used amounts of water. The 14 countries in Table 8 represent 86% of irrigated land and 87% of water abstracted for irrigation in EU27.

The calculations in Table 8 were done under the simplified assumption that each country has a homogeneous climate and mix of agricultural products. No regional differentiation at sub-country level was done. Table 8 shows that more than 57 % of abstracted water is used in surface flow irrigation (37 480 Mio. m^3), 34 % in spray technologies (22 450 Mio. m^3) and 9 % in trickle technologies (5 823 Mio. m^3).

Table 8 Irrigated area, water abstraction for irrigation and actual irrigation according to irrigation technology

Country	Irrigated Area	Irrigation method (%)			Water abstracted for irrigation	Actual irrigation[a)] (Million m^3/a)		
	1000 ha	Surface flow (furrow, border)	Spray (sprinklers, hose-reels, centre pivot)	Trickle	Million m^3/a	Surface flow (FAE 55 %)	Spray (FAE 75 %)	Trickle (FAE 90 %)
Bulgaria	800	50	49	1	713	412	296	5
Czech Republic	24	0.5	99	0.5	11	0	11	0
Denmark	447	0	95	5	156	0	150	7
France	2 600	10	85	5	3 120	414	2 580	126
Germany	485	0	95	5	142	0	136	6
Hungary	230	3	95	2	174	7	164	3
Italy	2 700	55	33	10	25 852	16 667	7 333	1 852
Poland	100	97	3	0	86	84	2	0
Portugal	650	76	19	5	6 551	5 354	982	215
Romania	3 081	10	90	0	9 120	120	792	0
Slovakia	183	0	100	0	65	0	65	0
Spain	3 020	45	33	21	18 089	9 923	5 336	2 830
Sweden	115	0	99	1	94	0	93	1
United Kingdom	108	0	95	5	1 896	0	1 817	80
Total	**14 435**				**57 862**	**32 981**	**19 757**	**5 124**
EU-27 (extrapolated)	**16 723**				**65 752**	**37 478**	**22 451**	**5 823**

a) Field application efficiency according to EEA: ratio between water used by a crop and total amount of water delivered to that crop

Source: Calculation based on [5]

Improvement potential to save water exists at different stages. A comprehensive water pricing scheme could lead to savings of 35 % to 40 % of water used in agricultural irrigation, which corresponds to 23 000 to 26 500 Mio. m^3 [5]. Such a measure would foster a shift from less efficient irrigation equipment such as surface flow installations towards spray and trickle technologies, mainly in the southern European countries and Poland, as these are the countries with the highest share in surface flow irrigation.

Increased conveyance efficiency, i.e. the efficiency in transporting water to the point of application, and an optimized mix between existing irrigation technologies can save up to 14 520 Mio. m^3 or 22 % of all water used for irrigation [5]. Further measures such as improved irrigation management can save a further 13 900 Mio. m^3 or 21 % of water [5]. These measures include e.g. improved scheduling of irrigation or optimized positioning of irrigation equipment. Spray irrigation systems can for example increase their application efficiency if they are installed close to the ground and are used at night [11].

Technological improvement is possible for spray and trickle irrigation technologies. Spray technologies such as centre pivot and sprinklers currently have an FAE of around 75 %. Low energy precision application spray irrigation systems (LEPA) have been developed in the United States which arrive in combination with an optimized crop pattern and improved agricultural practice at efficiencies between 95 % and 98 % [12]. Assuming a European wide application of

LEPA type irrigation with unchanged crop patterns and unchanged agricultural practices would presumably arrive at a FAE of less than 90 %. This would mean a saving of up to 3 350 Mio. m^3 or less than 5 % of water. However, comparative studies at the US department of agriculture show that LEPA and SDI (subterranean drop irrigation) lead to significant less crop yield than spray irrigation technologies like MESA or LESA (mid/low elevation spray application) [13]. The study also concludes that the optimum irrigation method in this specific case study depends more on the irrigation amount than on the irrigation technology.

Trickle irrigation currently arrives at a FAE of 90 % and is applied to 9 % of irrigated land in Europe, using 5 823 Mio. m^3 of water. Assuming that the FAE is technically increased to 95 %, a maximum of 291 Mio. m^3 or 0.4 % of all water used for irrigation can be saved.

The technological improvement potential of spray and trickle technologies amount together to a quantity of 3 640 million m^3 of water which can be saved (Table 9).

Table 9 Water abstracted for irrigation in the EU-27 and water saving potentials

Water abstracted for irrigation in EU	**Mio. m^3**	**%**
Total	65 752	100
Surface flow	37 478	57
Spray	22 451	34
Trickle	5 823	9
Saving potentials		
Water pricing scheme	23 000 to 26 500	35 - 40
Optimal mix of irrigation technologies & increased conveyance efficiency	14 520	22
Improved irrigation management	13 900	21
Improved spray technologies (FAE increase to 90 %)	3350	5
Improved drip irrigation (FAE increase to 95 %)	291	0.4

The figures in Table 9 indicate that water saving potentials differ widely between the different measures. It seems necessary to analyse the related administrative costs and benefits of each measure as well as the burden for farmers. However, such a discussion is out of the scope of this discussion paper.

5.2 Water-using products in the industrial sector

Water plays an important role in manufacturing industry. It is used as raw material, for cooling, cleaning and steam generation. It is also used for (liquid) waste disposal. Of the 15 % freshwater abstracted by industry, roughly half is used for cooling purposes and half for processing [7].

Data availability concerning industrial water consumption is limited. The available figures are not harmonised and inhomogeneous. These limitations make the analysis of water consumption at aggregated level of NACE categories difficult. When studying water consumption within individual manufacturing industries, only anecdotic figures are available. For a number of cases we fell back on US data, assuming that used technologies for example in chemicals manufacturing are more or less similar. Within the framework of this discussion paper, it was impossible to estimate the water and energy consumption according to individual industrial WuP as data is scarce. A more in-depth screening should be performed at a later stage. This would require much more effort than what could have been done in this study, including the establishment of contacts to industry associations and stakeholders for data gathering.

Against this background, no precise results concerning water consumption and related energy use could be calculated. Nevertheless it is possible to reveal trends and patterns of water consumption when comparing different manufacturing industries, which finally allow deriving recommendations with regards to the suitability of industrial WuP for the development of ecodesign implementing measures.

5.2.1 Aggregated industrial water consumption

Although data availability is scarce, from different sources an overview of water consumption in different manufacturing sectors can be generated for selected European Member States (Table 10).

Table 10 Sectoral water consumption in manufacturing industry for selected Member States

Manufacturing sector	Germany (2004)		Spain (2004)		Austria (2001)		Sweden (1995)		United Kingdom (1998)	
	Mio. m^3	Share	Mio. m^3	Share	Mio. m^3	Share	Mio. m^3	Share	Mio. m^3	Share
Food & Tobacco	2037	6%	197	11%	41	3%	74	4%	300	13%
Textile	78	0%	135	8%			12	1%	90	4%
Leather	3	0%	0							
Wood	45	0%	26	1%	9	1%	20	1%		
Paper & Printing	4749	14%	288	16%	103	7%	981	48%	210	9%
Coke, refineries & nuclear	2648	8%	70	4%			0	0%		
Chemicals	12777	38%	516	29%	548	35%	512	25%	670	29%
Rubber & Plastic	1042	3%	84	5%	3	0%	18	1%	10	0%
Non-metallic mineral products	674	2%	71	4%	11	1%	15	1%	80	3%
Metal	6554	20%	221	12%	834	54%	377	18%	330	14%
Machinery	610	2%	15	1%	5	0%	25	1%	110	5%
Electrical & optical equipment	603	2%	15	1%			10	0%	30	1%
Transport equipment	1741	5%	49	3%	3	0%	17	1%	30	1%
Other Industries	23	0%	86	5%			1	0%	160	7%
Sources: Germany [14], Spain [15], Austria [16], Sweden [17], United Kingdom [18]										

These figures and their variation of course reflect the industrial structure of the respective Member States. However, in order to identify the industrial sectors with the highest water consumption it is helpful to calculate the water intensity of the respective sectors, expressed in water use (m^3) per 1000 Euro value added (Figure 3).

As can be seen, the sectors with highest water intensity are chemicals, coke/refineries/nuclear, pulp/paper/printing and metal fabrication and processing. The following sectors are less, but still water intensive: food, textiles, mineral products and rubber/plastics.

To identify the large scale water saving potential at EU level it is important to see the absolute water consumption per sector. This was estimated by multiplying the water intensity as calculated above with value added figures from Eurostat for the five selected countries to interpolate for missing data (Figure 4).

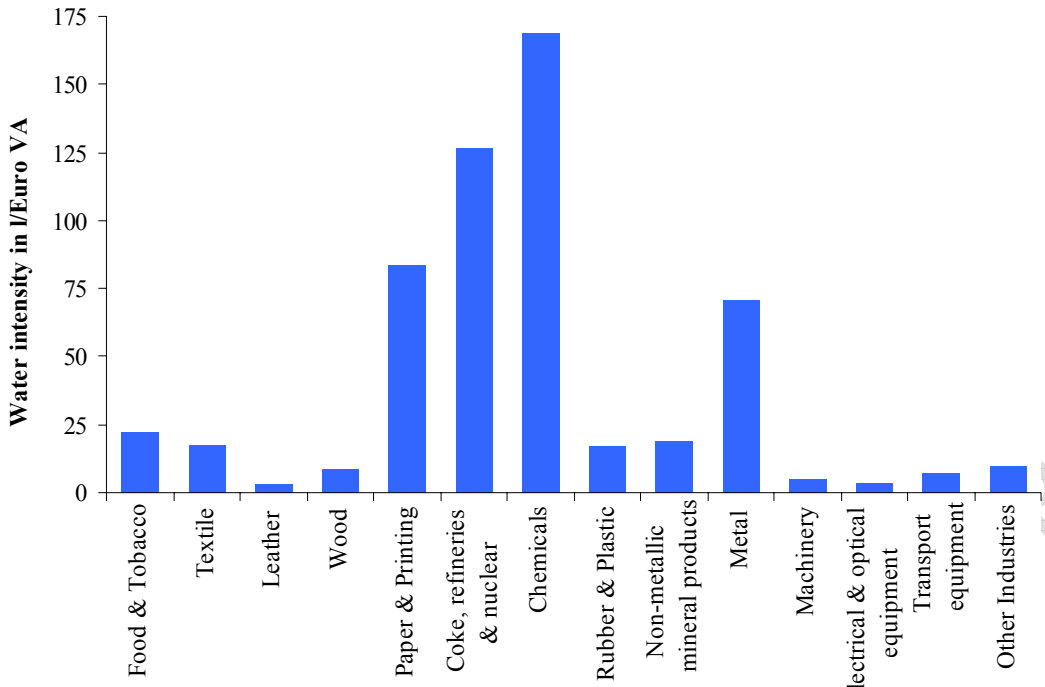

Figure 3 Average water intensity for industrial sectors for the five selected countries
Source: see Table 10, value added data from Eurostat

Comparing Figure 3 and Figure 4 it becomes clear that the production of chemicals (NACE DG) is the most water intensive sector and, due to the intensive chemical production in Europe, the sector which consumes most water in absolute terms in the five countries analysed.

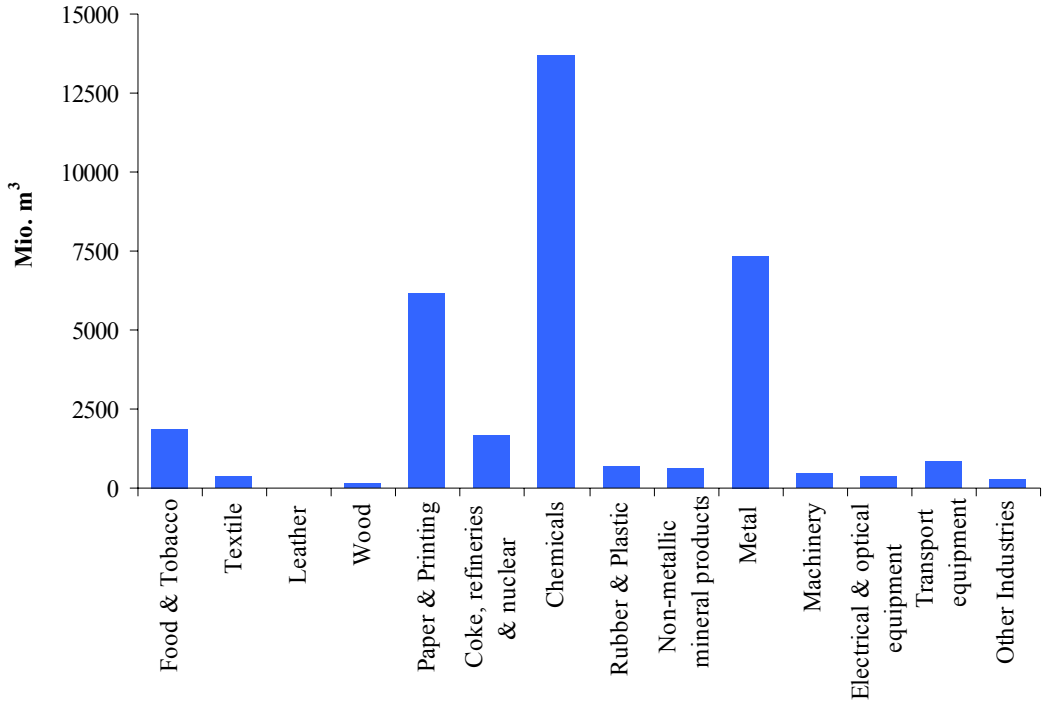

Figure 4 Estimated water consumption per industrial sectors in 2003 for the five selected countries
Source: see Table 10, value added data from Eurostat

Next to chemicals, follow metal fabrication and processing (NACE DJ), pulp, paper and printing (NACE DE) and the manufacture of food and tobacco (NACE DA). Coke, refined petroleum products and nuclear fuel (NACE DF) are the fifth largest water consuming sector. Textiles production (NACE DB) appear in this ranking as a low water consuming sector which is confirmed by other studies as well [19]. These six sectors together are responsible for 80% of water withdrawal in manufacturing industry [19] in the five selected countries.

The main use of water in industry is for cooling purposes, application in processing and steam generation. However, use of water varies between different industries (Figure 5).

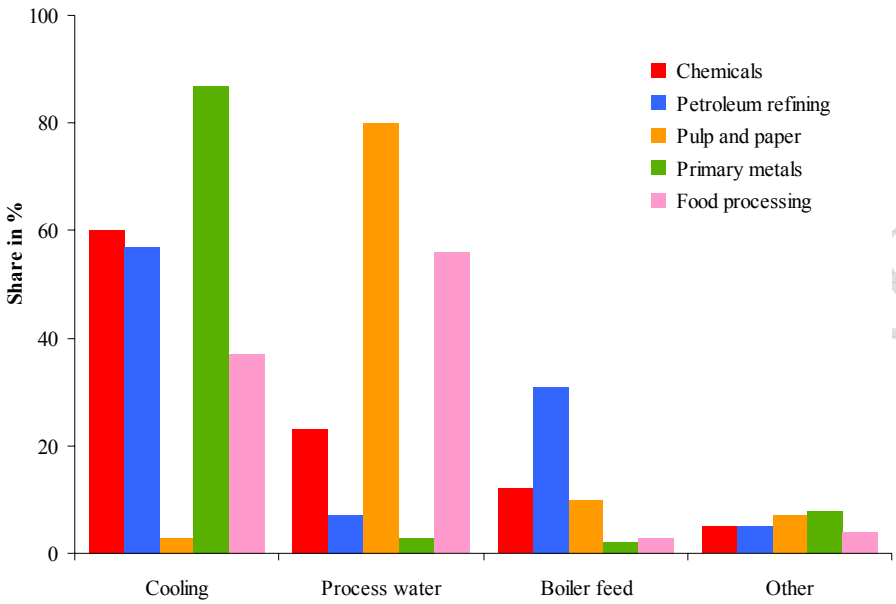

Figure 5 Types of water use by different industries. Boiler feed means heat/steam generation
Source: [20]

5.2.2 Chemicals

Amongst the sectors under consideration, the chemical industry is the most heterogeneous one in terms of product and process differentiation. Due to this diversity, generalisation about water use can hardly be made; however, most water in the chemical industry is used for cooling (Figure 6).

US data show that over the last four decades water consumption for cooling purposes declined, although production increased. The reason is increased air cooling and more efficient production technologies [20]. This indicates that the saving potential for water and related energy consumption is limited. The energy implications of shifting from water to air cooling (or dry cooling) could not be clarified in the frame of this analysis.

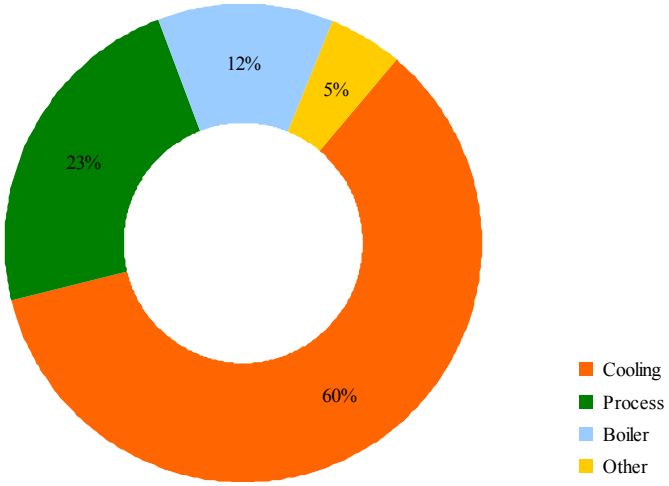

Figure 6 Water use in the chemical industry
Source: [20]

According to US data, organic chemicals manufacturing is the most water intensive sub sector, followed by inorganic chemicals, whereas agricultural chemicals production is least water intensive [20]. Water consumption does not only differ between sub-sectors, but also from product to product. Sulphur production for example requires around 8 litres of water per ton of product, whereas the production of lactose consumes around 600 litres per ton of product.

With regards to water related energy use, the highest consumption in the chemical industry is caused by steam generation, amounting to roughly half of overall energy use. However, steam generation figures amongst those processes with reduced water consumption, in the case of the chemical industry for around 12 % (Figure 5).

5.2.3 Metal fabrication and processing

In the basic metal industry, large quantities of water are used for cooling purposes, as can be seen in Figure 7. The EIPPCB BREF "Production of Iron and Steel" shows that the amount of cooling water varies between less than 5 and 100 m^3 per ton of steel [21]. Process water consumption for 1 ton of steel varies between 3.5 and 7 m^3 per ton of steel, for iron between 10 and 20 m^3 per ton of product. The variation depends on the technology used as well as on the geographic location of the production site.

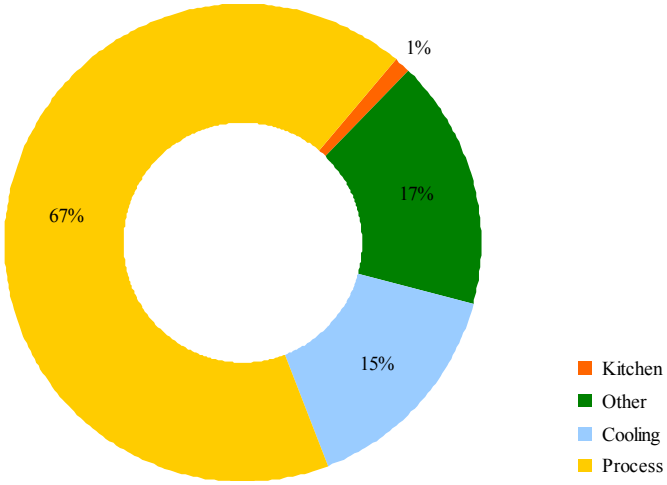

Figure 7 Water use in the fabricated metal industry
Source: [22]

In the US, the water use per production unit (ton of steel) decreased by more than 50 % over the last 20 years, and 95 % of the water is recycled within the plant [20]. This indicates that basic metal production technologies have become more water efficient, and the water saving potential is probably limited. In metal surface treatment large amounts of waters are used for cleaning and washing purposes [5].

A US study estimates the water savings potential in metal processing to be around 35 % [22]. This is partly achieved through change of praxis, e.g. "manually turn off rinse water when not in use" [22]. Other measures to save water actually add energy-using equipment to the process, e.g. timer controls, flow meters, spray rinses etc. A more detailed analysis would be needed in order to derive if there is a trade-off between water saving and increased use of energy. However, technical improvement of currently used WuP seems to play a minor role.

5.2.4 Pulp and paper, printing

Water consumption in large amounts is cased by pulp and paper production and less by printing. Figure 8 shows that almost 90% of water is used in the actual process. The main water uses are due to washing, screening, bleaching and forming.

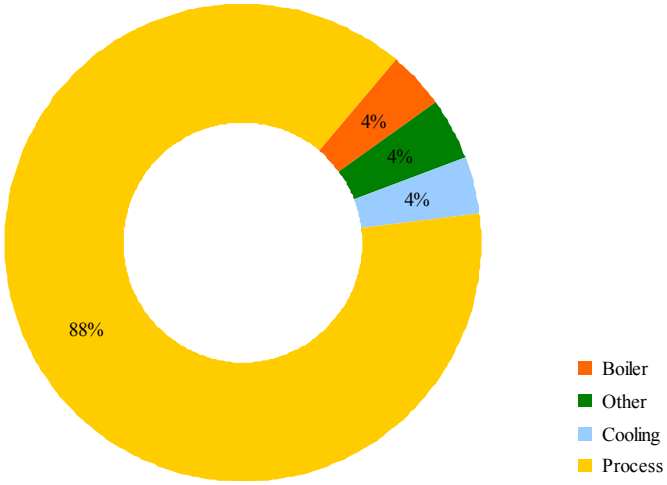

Figure 8 Water use in the pulp and paper industry
Source: [22]

Although water recycling technologies have penetrated the sector widely, water consumption is still high, and water related cost amount to up to 2 % of the production cost [5]. The significance of water in pulp and paper processing is illustrated by the fact that in a survey, 80 % of companies had tried to save water consumption through repairing leaks and identify unnecessary water uses. This indicates that in the processing steps like bleaching and screening water saving potential is rather limited, because it is technically indispensable. Consequently, water saving measures for the pulp and paper sector usually concentrates on recycling and reuse of water in the process, not on reducing the actual amount of consumed water.

Through recycling technologies, water use was reduced by around 80 % during the last 30 years according to US data [22]. However, the related energy use can be assumed to remain unchanged, as the actual flow water quantity did not decrease.

5.2.5 Coke and refinery

Water in petroleum refining and coal production is mainly used for cooling and steam generation purposes (Figure 9). According to US data, water consumption during the past 30 years has decreased by around 95 %. However, petroleum refining still accounts as one of the manufacturing sectors with the highest water intensity (Figure 3).

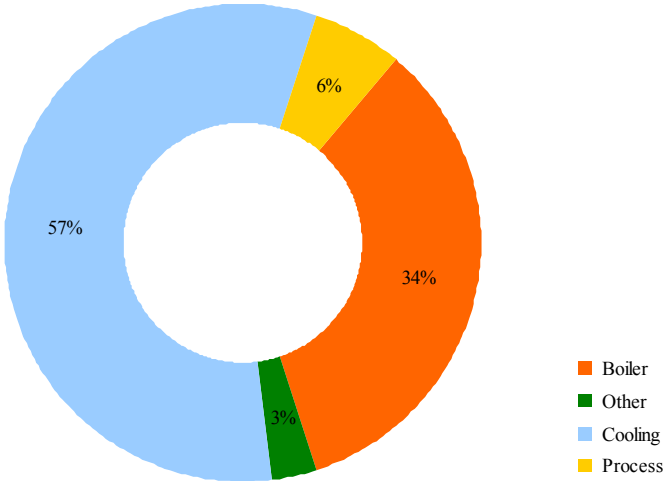

Figure 9 Water use in the petroleum and coal industry
Source: [22]

Similar to other industrial sectors, the reduction in water consumption over the past decades bases to a large extent on recycling and reuse technologies. That means that despite the reduced freshwater use, still the same amount of water for cooling and steam generation is used. Consequently the related energy consumption is assumed to be unchanged.

5.2.6 Textiles

Overall water intensity as well as absolute water consumption in the textile industry is far lower than in the other sectors discussed. It can be assumed that technical efficiency gains on the one hand and the decreasing weight of textile industry in Europe on the other hand are the main reasons for that. The EIPPCB BREF "Reference Document on Best Available Techniques for the Textiles Industry" lists the different processes related to water consumption in the textiles industry and makes explicit mention of the relation with energy use in a lot of processes [23]. Most water use in the textile industry is process related, cooling or steam generation play a minor role (Figure 10).

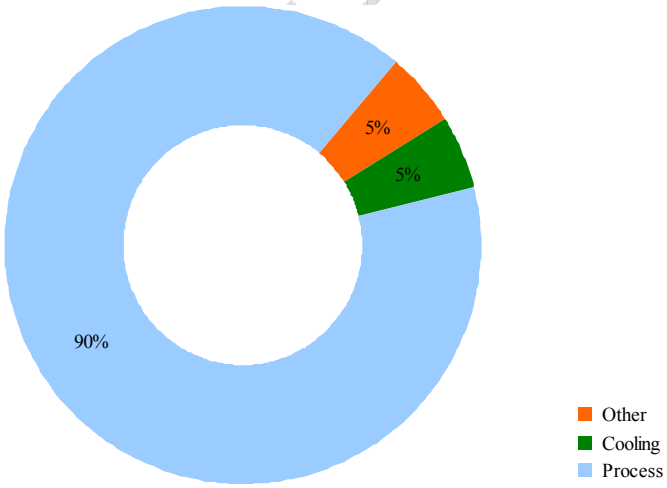

Figure 10 Water use in the textile industry
Source: [22]

Similar to the pulp and paper industry, it seems difficult to reduce process related water use. Water saving measures in the textile industry aim at recycling and reusing water in order to reduce freshwater use and to avoid unnecessary water losses, but do not target at actual reduce the process water quantities, as can be seen in Table 11. The only two efficiency oriented measures do not actually aim at reducing the intrinsic process water consumption, but to reduce water flow not linked to the process itself.

Table 11 Process water savings in the textile industry

End use	Type	Technology
Preparation: scouring	Reuse	Reuse of bleach, mercerising rinse water
Preparation: desizing	Reuse	Reuse of scouring, jet-weaving, bleach, mercerising rinse water
		Membrane filtration of desizing water
Continuous dyeing	Recycling	Countercurrent washing
	Efficiency	Use of automatic shut-off valves
	Reuse	Reuse of rinse water from dyeing for the dye bath makeup
VAT dyeing	Efficiency	Avoid overflow rinsing
Carpet dyeing	Reclaimed water	Use of reclaimed water in carpet dyeing
Sanitation	Reuse	Reuse of coloured wash water for cleaning floors and equipment in the print shop
Source: [22]		

5.2.7 Industrial water use according to purpose

Total interpolated water use in the EU-27 according to industry sectors is depicted in Table 12. Almost half of industrial water consumption is used for cooling. Two manufacturing sectors, pulp & paper and chemicals, depend heavily on water as a process input factor (apart from cooling, steam generation or cleaning purposes).

Table 12 Sectoral water consumption in the EU-27 according to purpose in Mio. m^3

Industry sector	Cooling	Process water	Boiler feed	Other	Total
Chemicals	8 223	3 152	1 645	685	13 705
Coke and refinery	946	116	514	83	1 659
Pulp and paper, printing	184	4 902	613	429	6 127
Metal fabrication and processing	6 392	220	147	588	7 347
Food	699	1 057	57	76	1 888
Textiles	18	317	0	18	352
Other	1 626	1 126	387	193	3 333
Total	**18 087**	**10 891**	**3 362**	**2 071**	**34 412**

5.2.8 Industrial water use according to WuP

The industrial water use according to purpose has to be further disaggregated to individual WuP. However, almost no data could be found on this issue. As this paper aims at supporting the selection of WuP for the application of the ecodesign directive, we are mainly interested in WuP that show high water use and that offer a high water saving potential. Secondly, the WuP to be selected should

not yet be covered by legislation. Thus, cooling equipment can be excluded as the EIPPCB BREF "Reference Document on the application of Best Available Techniques to Industrial Cooling Systems" already addressed these WuP [24].

With respect to heating, hot water & steam, the water use could not be disaggregated in the framework of this study (Table 13). However, some WuP used for this purpose are already covered by IMs (water heaters, boilers). Also, total water use for heating, hot water & steam (3 360 Mio. m^3) is comparably low (e.g. urban water use due to faucets and toilets is 12 660 and 17 200 Mio. m^3, respectively.

Table 13 Industry water consumption according to WuP

Purpose	WuP	Mio. m^3	Comment
Cooling[a)]	Open once-through cooling system	n.a.[b)]	Total cooling water use is about 18 090 Mio. m^3
	Open recirculating cooling systems	n.a.	
	Closed circuit wet cooling systems	n.a.	
	Open hybrid cooling	n.a.	
	Closed hybrid cooling	n.a.	
Heating, hot water & steam	Water heater	n.a.	Total water use for heating, hot water & steam is about 3 360 Mio. m^3
	Central heating boiler	n.a.	
	Central heating combi boiler	n.a.	
	Firetube boiler	n.a.	
	Watertube boiler	n.a.	
	Vapour generating boiler	n.a.	
	Superheated water boiler	n.a.	
Process water[c)]	Chemicals	3 152	Total process water use is about 10 890 Mio. m^3.
	Coke and refinery	116	
	Pulp and paper, printing	4 902	
	Metal fabrication and processing	220	
	Food	1 057	
	Textiles	1 245	
	Other	3 152	
Other	High-pressure & steam cleaner	21	Total other water use is about 2 070 Mio. m^3
	Fire sprinkler	104	
	Other WuP	1 947	

a) Products have been derived from the EIPPCB BREF "Reference Document on the application of Best Available Techniques to Industrial Cooling Systems" [24]; b) n.a. = no data available for disaggregation; c) has to be disaggregated further into different WuP, the figures thus show the maximum (hypothetical) water use if only one WuP would be responsible of total water use of the sector; d) assuming 1 % of water use for fire sprinklers and 5 % for high-pressure & steam cleaners

5.2.9 Water saving potential

Overall industrial water consumption decreased over the past decades mainly due to a restructuring of European industries from manufacturing towards more service oriented economies [25]. Further reasons for this development are that companies striving to minimise cost also aim at reducing water use as input material, and finally technological progress over the past decades has led to ever more efficient processes [5]. The saving potential for water and related energy consumption thus seems to be limited.

Almost half of industrial water consumption is used for cooling. In this area, two main water saving measures can be identified: the reuse of process water and the shift to air cooling. In both cases the implications for energy consumption remain unclear.

Two manufacturing sectors, pulp & paper and chemicals, depend heavily on water as a process input factor (apart from cooling, steam generation or cleaning purposes). Already applied water saving measures in these sectors indicate that this process water consumption is indispensable, which means that water efficiency is already very high.

Water saving potential in some sectors is also achievable through application of best practice in particular in cleaning and rinsing process steps. As in the case of cooling, a lot of process water saving measures in industry are related to recycling and reuse of water. Table 14 shows an overview of general water saving measures recommended by an UK agency for application in industry, independent of the sector. It can be seen that the recycling/reuse related measures have the highest water saving potential, but are hardly relevant for technological modifications at product level. However, the related energy use can be expected to remain the same, as the actual water flow quantities do not change.

Table 14 General water saving potential of industrial applications

Water saving measure	Saving potential in %
Closed loop recycling	90
Closed loop recycling with treatment	60
Automatic shut-off	15
Counter current rinsing	40
Spray/jet upgrades	20
Reuse of wash water	50
Scrapers	30
Cleaning in place	60
Source: [26]	

Although no quantities for the water and related energy saving potential can be given, it seems that mainly due to efficiency gains and unclear energy implications of water saving measures the application of the ecodesign directive to water-using products in industry may have limited potential for large scale improvements as compared to WuP in other sectors. Within this discussion paper, no thorough analysis of water saving potential in industry can be performed. A general saving potential of 10 % is thus assumed as water efficiency in industry is already high.

5.3 Water-using products in the urban sector (domestic and non-domestic)

The different water-using products that can be found in the urban sector (households, commercial and public buildings) are summarised in Table 15 which is derived from Table 5. With respect to data on water use, sometimes, household use and urban use are differentiated, e.g. water use in public buildings or even small enterprises. It is sometimes not clear if e.g. water used in industry by clients using the bathrooms is calculated as urban use or industrial water use (classification according to location vs. classification according to type of use). The industrial water use would then be classified in the respective industry sectors (Section 5.2).

The only WuP that do not use energy and that are not energy-related are toilets, urinals, and sprinklers for garden irrigation, in general. We assume that outdoor water use is supplied via external taps or hoses which are not connected to a boiler or a water heating device.

From the WuP shown in Table 15, there are some products already covered by EuP legislation: washing machines, dishwashers, air conditioning appliances, and water heaters/boilers.

Table 15 WuP in households and commercial buildings

Product group	Water-using product	EuP/ErP	Function/use	Water requirement
Sanitary tapware	Bathroom faucet	ErP	Personal hygiene, cleaning	Variable water requirement (e.g. aerators, using less water; use electric shaver)
	Kitchen faucets	ErP	Cooking, drinking, cleaning (food, dishes, etc.), personal hygiene	Fixed (drinking, cooking) and variable water requirement (cleaning)
	Showerhead	ErP	Personal hygiene	Variable water requirement (e.g. aeration, showerhead technology, e.g. water pressure)
Sanitary ware	Bathtub	ErP	Personal hygiene	Fixed water requirements (depending on size and shape of bathtub, water displacement of user, user behaviour)
	Toilet	--	Personal hygiene	Variable, depending on equipment, technology, user behaviour
	Urinal	--	Personal hygiene	Variable, depending on equipment, technology, user behaviour
	Bidet	ErP	Personal hygiene	Variable, depending on equipment, technology, user behaviour
Outdoor use	Swimming pool	ErP/EuP	Entertainment, sporting	Fixed water requirements for swimming pool (depending on volume; exchange rate of water)
	Sprinkler	--	Garden irrigation	Variable, , depending on equipment, technology, user behaviour
Heating & hot water	Water heater	EuP	Cooking, heating, personal hygiene	Fixed water requirements for cooking; variable for space heating and personal hygiene
	Central heating boiler	EuP	Heating	Variable water demand for space heating
	Central heating combi boiler	EuP	Cooking, heating, personal hygiene	Fixed water requirements for cooking; variable for space heating and personal hygiene
Cooling	Evaporative air cooler	EuP	Air-conditioning	Variable, , depending on equipment, technology, user behaviour
Cleaning equipment	High-pressure cleaner	ErP/EuP	Cleaning	Variable, depending on equipment, technology, user behaviour
	Steam cleaner	ErP/EuP	Cleaning	Variable, depending on equipment, technology, user behaviour
Household appliances	Washing machine	EuP	Cleaning	Variable, depending on equipment, technology, user behaviour
	Dishwasher	EuP	Cleaning	Variable, depending on equipment, technology, user behaviour
Other	Fire sprinkler	--	Fire fighting	Variable, depending on equipment, technology

Total EU-27 urban water use amounts to about 46 000 Mio m^3 according to [5]. Eurostat gives a value of about 29 000 Mio. m^3 of water use in the domestic sector in the EU-27 [27]. According to EUREAU, the total drinking water abstraction is 47 000 Mio. m^3 in the EU-27 [8]. Delivered drinking water is 27 000 Mio. m^3 for domestic uses and 11 000 Mio. m^3 for non-domestic uses (total 37 000 Mio. m^3). However, EUREAU figures only include abstraction and delivery by

EUREAU members (about 83 % of DW deliveries in term of population). Interpolation leads to 32 000 Mio. m^3 for domestic use and 13 000 Mio. m^3 for non-domestic use, respectively which corresponds to Ecologic [5] and Eurostat [27] data.

Per capita use of water in households in litres per day can be found in various sources. An overview over the data available is given in Table 16.

Table 16 Domestic or urban water use according to country in litres per person and day

Country	BIOIS [4][a)]	Eurostat [27][b)]	OECD [28][c)]	EEA [29][d)]	EWA [30][e)]	EEA [31][f)]	EUREAU [8][g)]	Ecologic [5][h)]
Austria	n.a.	127	n.a.	203	140	162	143	204
Belgium	n.a.	132	116	192	115	120	105	190
Denmark	n.a.	61	155	216	132	145	124	216
Finland	n.a.	n.a.	142	212	n.a.	n.a.	138	212
France	n.a.	143	n.a.	269	164	156	169	258
Germany	n.a.	126	n.a.	185	129	132	126	185
Greece	n.a.	149	n.a.	225	n.a.	n.a.	218	217
Ireland	n.a.	n.a.	n.a.	335	n.a.	n.a.	188	325
Italy	175	232	n.a.	479	n.a.	249	200	480
Luxembourg	n.a.	n.a.	n.a.	234	149	169	154	232
Netherlands	n.a.	205	n.a.	213	218	175	122	212
Portugal	184-210[i)]	155	n.a.	208	n.a.	n.a.	71	201
Spain	n.a.	215	n.a.	256	265	n.a.	190	252
Sweden	n.a.	196	217	284	n.a.	191	185	283
United Kingdom	153	n.a.	n.a.	291	343	n.a.	168	288
Bulgaria	133-186	124	n.a.	372	n.a.	n.a.	114	370
Cyprus	174	221	n.a.	140	n.a.	n.a.	269	148
Czech Republic	n.a.	129	130	209	n.a.	n.a.	97	207
Estonia	n.a.	n.a.	n.a.	144	100	n.a.	128	143
Hungary	n.a.	152	n.a.	201	135	n.a.	135	201
Latvia	n.a.	110	n.a.	20	n.a.	n.a.	n.a.	20
Lithuania	n.a.	67	n.a.	100	85	n.a.	102	100
Malta	n.a.	80	n.a.	141	n.a.	n.a.	75	139
Poland	123-178	105	n.a.	157	124	n.a.	78	159
Romania	n.a.	99	n.a.	301	n.a.	n.a.	118	306
Slovakia	n.a.	n.a.	n.a.	200	121	n.a.	86	201
Slovenia	n.a.	132	n.a.	302	143	n.a.	n.a.	302
Bosnia and Herzegovina	n.a.	97	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Croatia	n.a.	133	n.a.	n.a.	n.a.	n.a.	136	n.a.
Iceland	n.a.	n.a.	n.a.	719	n.a.	n.a.	283	n.a.
Macedonia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Norway	n.a.	366	205	497	224	n.a.	195	n.a.
Switzerland	n.a.	276	n.a.	402	160	237	160	n.a.
Turkey	n.a.	91	n.a.	173	n.a.	n.a.	n.a.	n.a.

a) household water consumption, data from the 2000s; b) supply to the domestic sector, Eurostat database on water use and population, average between 1997 and 2007; c) water use in the domestic sector, OECD database, population data from Eurostat; d) urban water use, data for 2001; e) household water consumption, data for 1995-2000; f) household and small businesses, data for 1995; g) domestic drinking water use, data for 2008; h) urban use of water and population data from Eurostat; i) range is for different regions/cities

5.3.1 Total domestic water use

Domestic use can be calculated as a share of total urban water use. This share is between 63 % according to Eurostat/Ecologic [5, 6] and 72 % according to [8].

When we use Ecologic data and apply a factor of 2/3, we can calculate the total domestic water consumption (population data from Eurostat for 2008) (Table 17).

Table 17 Total domestic water use according to country

Country	l/person and day[a)]	Population [b)]	Total domestic [Mio. m^3]
Austria	136	8 109 452	402
Belgium	127	10 357 347	480
Denmark	144	5 372 598	282
Finland	141	5 205 990	268
France	172	61 622 399	3 875
Germany	123	82 308 620	3 705
Greece	145	10 989 032	581
Ireland	217	3 962 424	313
Italy	320	57 681 269	6 744
Luxembourg	155	447 831	25
Netherlands	141	16 073 210	830
Portugal	134	10 360 431	506
Spain	168	41 692 473	2 560
Sweden	188	8 950 715	615
United Kingdom	192	59 465 845	4 167
Bulgaria	247	7 958 346	717
Cyprus	99	719 930	26
Czech Republic	138	10 259 866	518
Estonia	95	1 362 524	47
Hungary	134	10 163 878	497
Latvia	13	2 345 699	11
Lithuania	67	3 470 219	85
Malta	93	393 278	13
Poland	106	38 338 152	1 479
Romania	204	22 009 750	1 641
Slovakia	134	5 386 749	263
Slovenia	201	1 994 941	147
EU-27	**173**	**487 002 968**	**30 798**

a) Own calculations based on data from [5,6,8]; b) data from [6]

5.3.2 Domestic water use according to purpose

An overview over domestic water use according to purpose for selected countries is given in Table 18. On average, about 35 % to 40 % of water use can be attributed to hygiene (shower and bath), 20 % to 30 % to toilets, and 10 % to 20 % to laundry in OECD countries [4]. According to [32], in Europe, about one third of water is used for toilet flushing (33 %). Bathing and showering amounts to between 20 % and 32 % and washing machines and dishwasher to 15 %. Water used for cooking and drinking is only about 3 % [32].

Table 18 Domestic water use in selected countries according to purpose in %

Country	Source	Bathing/ showering/ personal hygiene	Toilet flushing	Washing clothes	Dish washing	Room cleaning, garden irrigation, car wash	Drinking & cooking	Other
Austria	[33]	43[a)]	24	16[b)]	2[c)]	6[d)]	4[e)]	4[f)]
Belgium	[34]	33	36	14	7	8[g)]	2	n.a.
Denmark	[35]	33	25	12	10	n.a.	7	13[h)]
Finland	[36]	29	14	30[i)]		2[j)]	4	21
France	[37]	39	20	12	10	6[k)]	7[l)]	6[m)]
Germany	[38]	36	27	12	6	6	4	9[h)]
Luxembourg	[39]	37	33	19[i)]		n.a.	3	8
Netherlands	[40]	42	28	18	5	n.a.	1[n)]	7
Spain	[41]	36[o)]	27	20	n.a.	n.a.	12	5
Sweden	[35]	30	20	15	20	n.a.	5	10[h)]
United Kingdom	[42]	33	30	13	8	7	4	5
Norway	[35]	31	23	19	15	n.a.	6	5[h)]
Switzerland	[43]	20	30	19	4	n.a.	15[e)]	2
New Zealand	[44]	30[p)]	18.6	23.7[b)]	1.2[c)]	8.7[q)]	n.a.	18.1[r)]
United States	[45]	21.4	30.9	25.1[b]	1.7[c]	n.a.	n.a.	20.9[s)]
Australia	[45]	33	17-21	26-27	n.a.	n.a.	n.a.	19-24[t)]
Canada	[45]	20.9	21.7	14.4	n.a.	4.9	n.a.	32.7[u)]

a) 0.8 % teeth brushing, 23.8 % bathing, 15.9 % shower; b) washing machines; c) dishwasher; d) 2.4 % room cleaning, 2.4 % car washing, 0.8 % flower watering, 0.8 % garden irrigation; e) 0.8 % drinking, 3.2 % cooking; f) a value of 7 % for washing is given (personal hygiene, maybe also dishwashing and clothes washing), we assume 3 % for personal hygiene and 4 % for other purposes; g) 4 % room cleaning, 4 % garden; h) small businesses; i) dishwashing and washing machines; j) outdoor use; k) car washing and garden; l) 1 % drinking, 6 % cooking, m) domestic divers (faucets); n) only cooking; o) only shower; p) 26.7 % shower, 3.3 % bathtub; q) outdoor use; r) 13.5 % tap, 4.2 % leaks; 0.4 % miscellaneous; s) 18.2 % faucet and 2.7 % other domestic; t) taps and other; u) 14.5 % miscellaneous and leaks, 18.2 % dishwasher and tap

Based on the data from Table 17 and Table 18, we can calculate the water use in Mio. m^3 per year according to purpose and country (Table 19).

Table 19 Domestic water use according to purpose in Mio. m^3 per year

Country	Bathing/ showering/ personal hygiene	Toilet flushing	Washing clothes	Dish washing	Room cleaning, garden irrigation, car wash	Drinking & cooking	Other
Austria	162	97	65	8	24	16	28
Belgium	158	173	67	34	38	10	n.a.
Denmark	93	71	34	28	n.a.	20	37
Finland	78	38	48	33	5	11	56
France	1511	775	465	388	233	271	233
Germany	1334	1000	445	222	222	148	333
Greece	197	144	82	49	33	27	51
Ireland	106	77	44	26	18	14	27
Italy	2281	1670	948	568	377	312	589
Luxembourg	9	8	3	2	n.a.	1	2
Netherlands	345	230	148	41	n.a.	8	58
Portugal	171	125	71	43	28	23	44
Spain	922	691	512	n.a.	n.a.	307	128
Sweden	185	123	92	123	n.a.	31	62
United Kingdom	1375	1250	542	333	292	167	208
Bulgaria	243	178	101	60	40	33	63
Cyprus	9	6	4	2	1	1	2
Czech Republic	175	128	73	44	29	24	45
Estonia	16	12	7	4	3	2	4
Hungary	168	123	70	42	28	23	43
Latvia	4	3	2	1	1	1	1
Lithuania	29	21	12	7	5	4	7
Malta	4	3	2	1	1	1	1
Poland	500	366	208	125	83	68	129
Romania	555	406	231	138	92	76	143
Slovakia	89	65	37	22	15	12	23
Slovenia	50	36	21	12	8	7	13
EU-27	**10769**	**7821**	**4330**	**2356**	**1575**	**1617**	**2330**

For EU-12 and countries without full information, the average of all values available for other countries is used (not weighted)

Figure 11 shows the share of the different purposes in the EU-27. The greatest share of water (35 %) is used for personal hygiene, followed by toilets (25 %) and clothes washing (14 %).

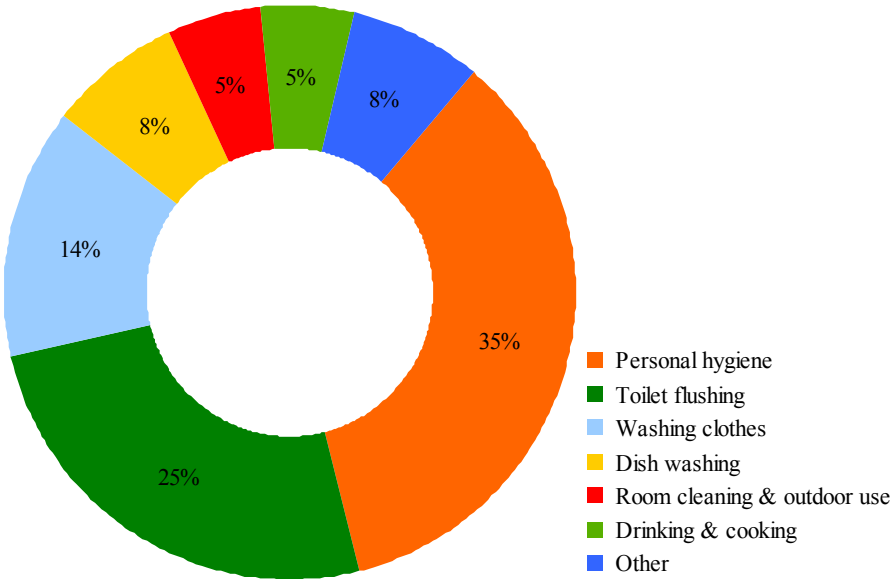

Figure 11 Domestic water use in the EU-27 according to purpose

5.3.3 Domestic water use according to WuP

Domestic water use according to purpose (Table 19) has to be attributed to the individual WuP. Domestic water use according to purpose and the WuP applied is shown in Table 20. Several studies analysing water use in detail are available. Also, some own assumptions had to be made. WuP use patterns can vary considerable. In general, influences are due to e.g. household size, income, equipment (washing machine, dishwasher, swimming pool) ownership, country.

In the following, water heaters and boilers have been excluded from the analysis. However, implicitly, they are included as they provide hot water for the other WuP that are addressed here (e.g. showerheads, faucets).

Table 20 Domestic water use according to purpose and corresponding WuP

Purpose	Water-using product
Bathing/showering/personal hygiene	Showerhead, bathtub, bidet, bathroom faucet, (kitchen faucet)
Toilet flushing	Toilet
Clothes washing	Washing machine, kitchen faucet, bathtub, bathroom faucet
Dish washing	Dishwasher, kitchen faucet
Room cleaning, garden irrigation, car wash	Kitchen faucet, bathroom faucet, high-pressure cleaner, steam cleaner, swimming pool, sprinkler
Drinking & cooking	Kitchen faucet, (bathroom faucet)
Other	Kitchen faucet, bathroom faucet, high-pressure cleaner, steam cleaner, evaporative air cooler, fire sprinkler

Bathing/showering/personal hygiene

For bathing, the bathtub is used in general. However, there exist also other possibilities, e.g. baby bathing is usually done using a bowl fed through the bathroom faucet. For showering mainly the shower is used which might also be an outdoor shower in summer fed by an external tap and a hose.

For personal hygiene, mainly the bathroom faucet is used. For washing one's hand, also the kitchen faucet might be used.

In general, we found that there is not much information on the distribution of water use for personal hygiene according to purposes (bathing, showering) and even less on the distribution according to WuP. Also, a very high variation between countries can be stated as personal hygiene practices differ a lot (e.g. due to cultural or climatic conditions).

For Austria, the data suggests that 23.8 % of total domestic water use is for bathing, 15.9 % is for shower, 3 % for washing and 0.8 % for teeth brushing [33]. Of total personal hygiene, thus, 55 % is for bathing, 37 % for showering, 7 % for washing and 2 % for teeth brushing.

In Spain, we find a value of 36 % for showering. However, no data for bathing is available as it is included in 'other' which amounts to 5 % of total domestic water use [41].

For the UK, several data sources are available: We can first calculate water use for showering as the average shower use of 6.8 l/min and 1.02 uses per day per household is given in [46]. The average shower duration is 5.2 minutes [46]. With a number of households of about 26 Mio. in 2006, water use for showering is about 340 Mio. m^3. Compared to total domestic water use for showering/bathing/hygiene (1 375 Mio. m^3, see Table 19), this is about 25 % of water consumption and 8 % of total water use. Bathtub use in the UK is calculated as follows: Average use is 88 litres per bath and bath utilisation is 265 uses per bath and year according to [47]. Bathtub stock in the UK is about 25 Mio. (96 % of all households own a bath) [47]. Thus, about 540 Mio. m^3 of water are used for bathing annually, which is about 40 % of water consumption for showering/bathing or personal hygiene and 13 % of total domestic use. Other sources give the following values for bathing and showering in the UK: according to [48], the share of water use for bathing is 15.1 % of total household consumption, and shower water use is 23.15 % on average. In [49] the shares are given with 14.5 % and 8.0 % for bath and shower, respectively. In [50] it is assumed that in the UK, the average water use for bathing is 38 litres per household and day which corresponds to about 360 Mio. m^3 per year. Thus, bathing is about 26 % of water consumption for showering/bathing/hygiene and 9 % of total domestic use. For showers, the data from [50] suggest a duration of 5 minutes per shower and 0.6 showers per person and day. Together with flow rate of 6.8 l/min as of [46], total water use for showering is 34 l per shower and 20.4 litres per person and day which sums to about 450 Mio. m^3 per year. Thus shower use is about 32 % of water consumption for showering/bathing and 11 % of total water use. The shares thus vary between 9 % and 15 % over total water use for bathing and between 8 % and 23 % for showering. Shares for personal hygiene vary between 26 % and 40 % for bathing and 25 % to 32 % for showering.

To conclude, reliable data are scarce for water use due to bathing, showering and other personal hygiene purposes. In this paper, we assume as EU-27 average values 40 % for bathing, 40 % for showering and 20 % for other personal hygiene (e.g. hand washing, washing, and teeth brushing).

No information could be found with respect to bidet water use. Bidets thus have been excluded from the study.

Clothes washing

Washing clothes can take place in a washing machine, but washing can also be performed manually in e.g. a bidet, bathtub, or a bowl fed by faucets. The washing machine ownership of households in Europe is assumed to be 100 % [51]. In England and Wales, washing machine ownership of households was 96 % in 2003 [52]. We assume that 5 % of water consumption due to clothes washing is used via faucets and 95 % via washing machines.

Dish washing

It is assumed that dish washing is done using dishwashers or by manual dish washing. Furthermore, we assume that dish washing is done in kitchens only (by kitchen faucets only) and dish washing in bathrooms or outdoor is not assumed.

According to [50], it was estimated that households without dishwasher use 80 litres of hot water per person and week (which corresponds to 8 washing up events, with 1 bowl of 10 litres for each event). For households with dishwasher, it was estimated that 23 litres of hot water per person and week are used (2.3 hand washing events with 1 bowl of 10 litre each event) [50].

Dishwasher ownership of households in Europe is 69 % according to [53]. According to [53], dishwasher use is on average 4.1 cycles per households and week or 1.3 cycles per person and week. Manual dishwashing is also performed in households owning a dishwasher (3.3 cycles per person and week). Manual dishwashing water use varies a lot between countries (on average 103 litres per cycle, 2.5 kWh energy use; 79 minutes) [53]. The average dishwasher (12 place settings) uses about 1.070 kWh electricity and 15.2 litres of water per cycle [53].

To summarise, the water consumption is assumed as follows: Households owning a dishwasher use 23 litres of water per person and week for manual dishwashing and about 20 (1.3*15.2) litres of water per person and week for dishwashers (total 43 litres of water). The households without dishwasher use 80 litres of hot water per person and week. Total averaged water use is 30 l litres of water per person and week for the 69 % of dishwasher owners and about 25 litres of water per person and week for non-dishwasher owners. Average water use for dish washing by dishwashers thus is 25 % and 75 % by kitchen faucets.

Room cleaning and outdoor

External water use is dominated by garden watering according to [54]. Garden watering is performed manually (hose or watering-can) or via a sprinkler system. Other outdoor use comprises car washing, ponds, the use of pressure washers and recreational water use (swimming pools, paddling pools, outdoor showering).

Distribution of outdoor use to different purposes is difficult because there is almost no data available. Data for Austria suggests the following shares over total domestic water use: 2.4 % room cleaning, 2.4 % car washing, 0.8 % flower watering, and 0.8 % garden irrigation [33]. In Belgium, 4 % of water is used for room cleaning, and 4 % for garden irrigation [34].

We assume on average 30 % of water use for room cleaning. Another 25 % are assumed for car wash, 30 % for garden irrigation, 10 % for flower watering, and 5 % for swimming and paddling pools. With respect to garden irrigation, we assume that 50 % is delivered via sprinklers.

In addition, high pressure cleaners are used in outdoor environments. However, they will be covered more in detail in Section 5.4 as a ‘horizontal technology’. We did not find any data on the share of high-pressure cleaners over total outdoor water use. However, to allow for a first assessment of water use due to high-pressure cleaners, we assume that 80 % of water for room cleaning and outdoor use is delivered through faucets while 20 % is used by high pressure cleaners. Obviously, this might be an overestimation of high-pressure cleaner water use; however, calculated water use is inline with the calculations in Section 5.4.

Drinking & cooking

Water for drinking and cooking is mainly provided by the kitchen faucet. Drinking from bathroom faucet is not assumed.

Other

Other use comprises different items according to country and reference. Sometimes, personal washing that uses water from faucets is included here. Also, room cleaning or small businesses can be included here. Here, we assign 100 % of water use to faucets. The water use due to evaporative air coolers and fire sprinklers has not been assessed.

Conclusions

On EU-27 level, the calculated distribution of domestic water use according to purpose and WuP is shown in Table 21. However, it has to be taken into account that this distribution can only be seen as a first estimate due to data limitations. Especially, the distribution of water use between bathtub, faucets, and shower for personal hygiene reasons is highly uncertain.

Table 21: Domestic water use according to purpose and WuP in Mio. m^3

WuP	Bathtub	Shower	Faucet	Toilet	Washing machine	Dish-washer	High-pressure & steam cleaner	Swim-ming pool	Sprink-ler	Total
Personal hygiene	4308	4308	2154							10769
Toilet flushing				7821						7821
Washing clothes			217		4114					4330
Dish washing			1767			589				2356
Room cleaning & outdoor use			961				299	79	236	1575
Drinking & cooking			1617							1617
Other			2330							2330
Total	**4308**	**4308**	**9045**	**7821**	**4114**	**589**	**299**	**79**	**236**	**30798**

In total, approximately one third of total water use in households is delivered via faucets (Figure 12), followed by water use of toilets (25 %) and bathtubs and shower (14 % each). Dishwashers, high-pressure cleaners, swimming pools and sprinklers only account for very small shares (up to 2 %) of domestic water use.

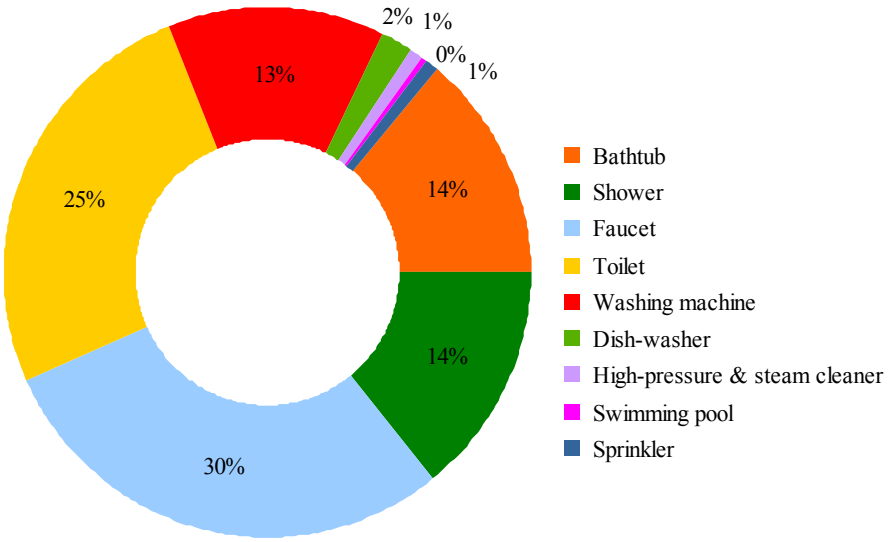

Figure 12 Domestic water use in the EU-27 according to WuP

Domestic water use includes also 'invariant' water use or water use that can not be changed by measures like aerators in faucets and the like. Also bathtub use (4 310 Mio. m^3) could be considered as 'invariant' unless bathtubs are made smaller. Also, water used for irrigation, watering, and swimming pools is difficult to reduce unless evaporation and/or evapotranspiration are decreased. This invariant outdoor water use is about 710 Mio. m^3 in the EU-27. In addition, water use for cooking and drinking can be considered as invariant (1 620 Mio. m^3). Thus, in total, about 20 % of domestic water use can be considered as invariable. O course, part of the 'invariable' water use can be reduced by behavioural changes, e.g. taking a bath less often, use less water when washing one's hand.

5.3.4 Non-domestic water use according to WuP

In Figure 13, the non-domestic building water use in different (non-domestic) sectors in the UK is shown. In most sectors, WC and urinal water use dominate the total water use.

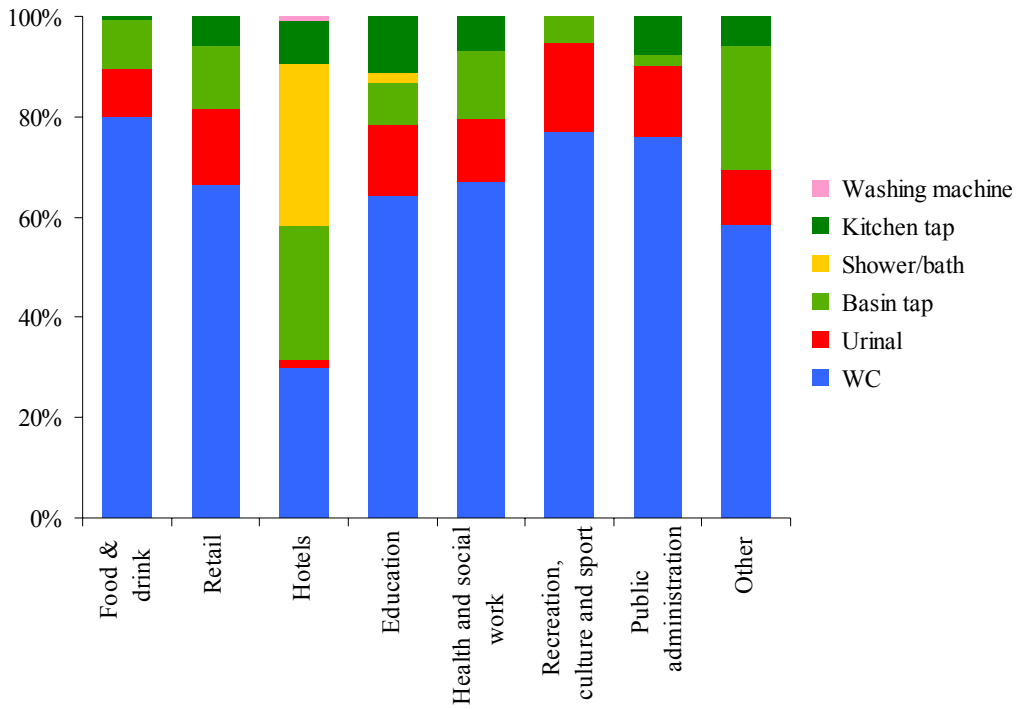

Figure 13 Water use in non-domestic buildings according to WuP for different sectors in the UK
Source: [47]

The average water use in non-domestic buildings is provided in [55] for England and Wales and shown in Table 22.

Table 22 Non-domestic water use according to WuP in England and Wales

Water-using product	Water consumption non-domestic in Ml per day	Share in %
Toilet	415	61
Urinal	74	11
Basin faucet	116	17
Bathtub/showerhead	32	5
Kitchen faucet	44	6
Washing machine	<1	0
Dishwasher	0	0
Outdoor use	0	0
Source: [55]		

To calculate the total water use in non-domestic buildings, we use the information from Table 17 (non-domestic water use is 1/3 of total water use). The shares of England and Wales (Table 22) are applied to all countries. Total non-domestic water use is shown in Table 23.

Table 23 Non-domestic water use according to WuP in Mio. m^3

	Toilet	Urinal	Basin faucet	Bathtub/ shower-head	Kitchen faucet	Washing machine	Total
Total	9377	1672	2621	723	994	11	15399

So far, high-pressure cleaners have not been regarded in non-domestic water use as no data has been available. However, high-pressure cleaners will be analysed more in detail in Section 5.4 as a 'horizontal technology'.

5.3.5 Energy use according to WuP

Energy use for hot water

Total domestic water use in the EU-27 (Table 21) can also be calculated as average daily use per inhabitant and is shown in Table 24.

Table 24 Domestic water use according to purpose and WuP in l per person and day

WuP	Bathtub	Shower-head	Faucet	Toilet	Washing machine	Dish-washer	High-pressure & steam cleaner	Swim-ming pool	Sprink-ler	Total
Personal hygiene	24.2	24.2	12.1							60.6
Toilet flushing				44.0						44.0
Washing clothes			1.2		23.1					24.4
Dish washing			9.9			3.3				13.3
Room cleaning & outdoor use			5.4				1.7	0.4	1.3	8.9
Drinking & cooking			9.1							9.1
Other			13.1							13.1
Total	**24.2**	**24.2**	**50.9**	**44.0**	**23.1**	**3.3**	**1.7**	**0.4**	**1.3**	**173.3**

The average cold and hot water use of households was assumed according to [50]: The hot water use in 2008 was about 103 l per household and day (Table 25) which is about 50 % of total water use (without accounting for toilet flushing, dishwashers, and outdoor water use). In [56] we find an average hot water use of 122 l per household and day for a survey of 120 dwellings. According to [57], 1/3 of all water used in households is hot water. In total, 68 litres of hot water are used per person and day in Canada [57], which as a comparable figure confirms the approximate range of consumption values.

Table 25 Average household hot and cold water consumption according to WuP in l/day

Appliance	1992	2008
Shower hot	2	14
Shower cold	7	19
Bath hot	32	32
Basin hot	18	22
Basin cold	n.a.	20
Washing machine hot	9	5
Washing machine cold	69	38
Kitchen hot	n.a.	30
Kitchen cold	n.a.	24
Total	**137**	**204**
Source: [50]		

According to the data in Table 25, total faucet use is 96 litres per household and day (basin and kitchen use) which corresponds quite well with our estimate of 51 litres per person and day (Table 24). Also, the values for showering (33 l per household and day) and bathing (32 l per household and day) show good accordance with our own calculations (24 l per person and day for each of the two).

If we want to estimate energy consumption, we have to assume an average temperature for the hot water used. For showering, 39 ºC are assumed as comfortable temperature according to [50]. No information on bathing water temperature was available from [50]. In [56], the mean delivery temperature at the boiler is given with about 52 ºC. Temperatures at outlets or destination (taps, bathtub) are varying between 30 ºC and 38 ºC.

We thus assume in this paper for a rough assumption of energy use for hot water supply a temperature of 39 ºC. As an additional assumption, we estimate that the water has to be heated from 19 ºC to 39 ºC, thus a heating of 20 ºC is required. For 1 l of water this means that 83.6 kJ of energy is needed.[1]

If we assume that about half of the water used by faucets, shower and bathtubs is hot (which is about 30 % of total water use), the amount of water to be heated is about 8 830 Mio. m^3 in the EU-27 or 49.7 l per person and day. In total this corresponds to about 740 PJ in the EU-27. When assuming also an average boiler efficiency of 75 %, the energy use is about 980 PJ per year in the EU-27.[2]

The annual demand of energy in the residential sector for all purposes (including space heating, lighting, transport) is 320 538 ktoe in 2010 according to [58] which amounts to about 13 420 PJ.[3] Thus, domestic hot water consumption is responsible for about 7 % of household energy use. This corresponds well with available data on residential energy use, for example, in Germany, the share of hot water ranges from 10 % to 13 % for 1995 to 2007 [59].

Energy use for appliances

The average dishwasher with 12 place settings uses 1.07 kWh electricity and 15.2 litres of water per cycle (see Section 5.3.3). In total, the EU-27 domestic water use for dishwashers is assumed to be about 590 Mio. m^3 (see Table 21). Thus, the total energy demand is about 41 TWh which corresponds to about 150 PJ. Compared to the EU-27 total of 13 420 PJ, this is only about 1 % of the total annual energy consumption in the residential sector.

The average washing machine is assumed to use 0.998 kWh electricity and 50.7 litres water per cycle (see Section 5.3.3). As we assumed the EU-27 water use of washing machines to be about 4 100 Mio. m^3 (see Table 21), the energy use is about 80 TWh or about 290 PJ which is about 2 % of the total annual energy consumption in the residential sector.

[1] Specific heat capacity is 4.1813 J per g and K according to "M. Moran, H. Shapiro, Fundamentals of Engineering Thermodynamics" 6th Edition Mc GrawHill, .

[2] This might be very optimistic. According to [61, 62], average efficiencies in 2010 are 64 % for boilers and 42 % for water heaters in the EU-27 in a realistic scenario. Thus energy use and, consequently, energy savings due to domestic hot water provision might be underestimated (see Section 5.3.7).

[3] We assume that 1 ktoe equals 0.041868 PJ.

Energy use for high-pressure cleaners

To estimate the energy used for high-pressure cleaners, several assumptions had to be made. The water use of a high-pressure cleaner was estimated to be about 450 l per hour. The electric load of such clears is about 2 kW.[4] In order not to underestimate the energy demand, we assume a 4 kW load instead. As total water use due to high-pressure cleaners is about 300 Mio. m^3 (see Table 21), the energy consumption and EU-27 level is about 2.7 TWh energy needed which is about 10 PJ. This is approximately 0.1 % of total annual energy consumption in the residential sector (despite water and energy use have been overestimated).

Energy use for non-domestic water use

Water use in non-domestic buildings is summarised in Table 23. Again, we estimate that 50 % of water use by faucets, bathtubs and showers is hot (about 2 170 Mio. m^3).

Assumptions on temperature and boiler efficiency where the same than for domestic energy use. Thus, total energy demand is about 240 PJ (83 % due to faucets and 17 % due to shower and bath).

5.3.6 Energy and water saving potential

In Table 26, the water and energy use of domestic WuP in the EU-27 is shown. Interestingly, the energy use due to faucets and showers about the same order of magnitude (or even greater) than for washing machines and dishwashers which are already scheduled for EuP measures.

Table 26 Domestic WuP: summary of water and energy use

Water-using product	EuP/ErP	Variable water use in Mio. m^3/a	Invariable water use in Mio. m^3/a	Energy use in PJ/a	Comment
Bathtub	ErP	---	4 308	240	The exact distribution between bathtub and shower is highly uncertain
Showerhead	ErP	4 308	---	240	
Faucet	ErP	6 719	2 326	504	
Toilet	---	7 821	---	---	Non-EuP and Non-ErP
Washing machine	EuP	4 114	---	291	Already covered by EuP
Dishwasher	EuP	589	---	149	Already covered by EuP
High-pressure & steam cleaner	ErP/EuP	299	---	10	See also Section 5.4
Swimming pool	ErP/EuP	79	---	n.a.[a)]	
Sprinkler	---	236	---	---	

a) n.a.: not analysed

Table 27 shows the summary of the water and energy use of non-domestic WuP. By far the highest share of water is used by non-EuP and non-ErP WuP (toilets, urinals). Related energy use is highest for faucets.

[4] See, for example, the Kärcher comfort class (http://www.karcher.de/aus/Products/Home__Garden/Pressure_washers/) pressure cleaners.

Table 27 Non-domestic WuP: summary of water and energy use

Water-using product	EuP/ErP	Variable water use in Mio. m^3	Invariable water use in Mio. m^3	Energy use in PJ	Comment
Bathtub	ErP	---	362	20.1	The exact distribution between bathtub and shower is highly uncertain
Showerhead	ErP	362	---	20.1	
Faucet	ErP	3 615	---	201.5	
Toilet	---	9 377	---	---	Non-EuP and Non-ErP
Urinal	---	1 672	---	---	Non-EuP and Non-ErP
Washing machine	EuP	11	---	0.8	Already covered by EuP
Dishwasher	EuP	n.a.	n.a.[a)]	n.a.	Already covered by EuP
High-pressure & steam cleaner	ErP/EuP	n.a.	n.a.	n.a.	See also Section 5.4

a) n.a.: not analysed

To calculate the water end energy savings that might be achieved we estimate that tap water flow rates can be reduced by 20 % to 30 % by e.g. installing new water efficient tap ware or low flow aerators [4]. Installation of low flow showerheads or aerated showerheads can lead to water savings. On average, flow rate reductions of 28 % are feasible without impairing shower quality [50]. In order not to overestimate the saving potential, we assumed a saving potential of 20 % of variable water use from showerhead and faucet.

The same applies for toilets: water-efficient toilets may use as less as 4 litres per flush compared to average toilets that use about 11 litres per flush [4]. However, we estimated the saving potential to be 20 % on average.

Increasingly, waterless urinals are installed in commercial and office buildings. Currently, only 1 % of all urinals are waterless.[5] However, their use is recommended by various authorities (see, e.g. [60]). Increasing use of waterless urinals might lead to increase use in chemicals which are needed as odour traps in some design variants [60]. We are assuming a 20 % market share of waterless urinals, i.e. a water saving potential of 20 %.

The average water and energy consumption of household appliances was assumed to be 1.07 kWh electricity and 15.2 litres of water per cycle for dishwashers and 0.998 kWh electricity and 50.7 litres water per cycle for washing machines (Section 5.3.5) according to [51]. The draft implementing measures foresee the following minimum performance requirements: 9 l of water and 0.950 kWh per cycle for dishwashers and 39 l of water and 0.850 kWh per cycle for washing machines. The average energy saving potential thus is 10 % for dishwashers and 15 % for washing machines. For water, the saving potential is 40 % for dishwashers and about 20 % for washing machines.

For high-pressure cleaners and steam cleaners, a saving potential of 20 % for water and energy was assumed.

Total water and energy use as well as the saving potential of urban WuP is summarised in Table 28. Apparently, the highest water saving potential exists for toilets, faucets and showerheads. The energy saving potential is greatest for faucets, followed by showerheads.

[5] See: http://features.csmonitor.com/innovation/2009/03/19/waterless-urinals-cheap-green-but-many-think-%E2%80%98gross%E2%80%99/

Table 28 Urban WuP: water and energy use and saving potential

Water-using product	Water use	Water saving potential		Energy use	Energy saving potential
	Mio. m^3	Mio. m^3		PJ	PJ
Bathtub	4 669	---		260	---
Showerhead	4 669	934		260	52
Faucet	12 660	2067		706	141
Toilet	17 198	3440		---	---
Urinal	1 672	334		---	---
Washing machine	4 125	825		292	44
Dishwasher	589	236		149	15
High-pressure & steam cleaner	299	60		10	2
Swimming pool	79	---		n.a.	n.a.
Sprinkler	236	---		n.a.	n.a.

It is estimated that the EuP Implementing Measure for TVs will save 43 TWh or 150 PJ per year.[6] For refrigerators and freezers, the reduction potential is estimated to be about 6 TWh or 22 PJ annually.[7] The estimated savings for faucets and showerheads are about 140 PJ and 50 PJ, respectively (assuming 75 % boiler efficiency) and thus the same size or even greater than for the products already covered by EuP. If we include the effects of the IMs on water heaters and boilers, efficiency might be increased to 96 % for boilers and to 66 % for water heaters in 2020 in a realistic scenario compared to BaU. If we assume an average efficiency of 95 % instead of 75 %, the energy savings due to reductions in water use of faucets and showerheads would only amount to about 110 and 40 PJ, respectively.

Assuming an average efficiency of 95 % seems to be quite optimistic as this might be achieved for boilers but not for water heaters. An average efficiency would be that almost 100 % of domestic hot water is provided by boilers. We are not aware of any study analysing the shares of boilers and water heaters in domestic hot water provision, but we can compare the stock of these appliances as a first indication. In 2010 the stock is about 277 000 water heaters and 120 000 boilers and in 2020 about 307 000 water heaters and 140 000 boilers according to preparatory studies [61,62]. Efficiency gains thus might be overestimated and thus possible energy savings underestimated.

5.3.7 Cross-check of energy use for domestic hot water

According to [63], the total energy consumption of households in the EU-27 is 304 688 ktoe which corresponds to 12 800 PJ in 2006. In [58], the EU-27 energy consumption is given with 320 538 ktoe which is about 13 500 PJ annually. Both studies apparently do not include private transport. On average, the total annual energy consumption of EU-27 households might be estimated at about 13 000 PJ.

The preparatory study on the eco-design of boilers estimates that the EU-25 energy consumption due to central heating system boilers in 2010 is about 10 500 PJ which would correspond to about 80 % of household energy use in the EU [64].[8] However, the preparatory study does not only

[6] See: http://www.eceee.org/Eco_design/products/televisions/.

[7] See: http://www.eceee.org/Eco_design/products/domestic_fridges_and_freezers/.

[8] Assuming a total household energy demand of 13 000 PJ per year in the EU-27.

include boilers in the domestic sector but all boilers sold in the EU which means that also boilers used in e.g. agriculture, industry, commercial and institutional buildings are included [61].

The energy use of water heaters is 3 900 PJ per year in 2010 according to the preparatory study on the eco-design of water heaters [65]. However, this also includes combi-heaters that do not only provide hot water for sanitary purposes but also hot water for space heating. Approximately 20 % of the energy are used by combi-heaters, the hot water supply thus needs approximately 3 100 PJ per year which is about 24 % of total household energy use. Again, this study does not only include water heaters in households but also appliances in other sectors [62].

We estimated the domestic energy consumption for hot sanitary water to be 240 PJ for bathtub use, 240 PJ for showerheads, and about 500 PJ for faucets, in total 980 PJ per year. This includes only the energy that is used for heating the amount of water that is withdrawn. Any possible losses in pipes or the energy that is used to maintain the temperature of the water in the boiler are not included. The figures we calculated thus are lower than the energy demand from the preparatory studies, which is correct as we only include households and not other sectors. To cross-check the results we can compare the share of energy use for hot water from our calculations (about 7 %) with the shares found in other studies (Table 29).

Table 29 Share of residential energy use in buildings according to purpose in %

Country	Year	Source	Space heating	Space cooling	Hot water	Lighting	Cooking	Other[a)]
Germany	2007	[59]	73	n.a.	12	2	n.a.	14[b)]
United Kingdom	2006	[66]	58	n.a.	25	n.a.	3	15[c)]
New Zealand	1996	[67]	36	n.a.	38	5	6	15[d)]
United States	2005	[68]	32	11	13	12	4	28
Canada	2005	[69]	60	3	18	5	n.a.	14 [e)]
Australia	2007	[70]	41	3	16	n.a.	5	34[f)]
EU-15	2004	[71]	68	n.a.	14	n.a.	4	14[c)]
EU-27	2007	[58]	66	1	22	5	n.a.	6[e)]

a) including e.g. electronic equipment and appliances, excluding transport; b) including space cooling and cooking; c) including lighting and space cooling; d) including space cooling; e) including cooking; f) including lighting

From literature, we see that domestic hot water use varies a lot between countries, depending on e.g. climate, household appliance ownership, cleaning habits. However, we seem that the share of 7 % we estimated for hot water use for the EU-27 is at the lower range of literature data, thus, we might assume that energy use for hot water has been underestimated in our research. One explanation might be that we did not account for energy losses in pipes or for energy used to maintain the temperature in hot water storage systems but only accounted for the energy used to heat the water. Also, we assumed that hot water temperature it about 40 ºC while temperatures in boilers usually are higher (about 60 ºC) which has not been taken into account.

5.4 Water-using products used in all sectors horizontally

Several water-using products (WuP) are used in households as well as in industry or service sectors. Two of these products will be analysed more in detail: high-pressure cleaners (Section 5.4.1) and steam cleaners; and car-wash facilities (Section 5.4.2).

5.4.1 High-pressure & steam cleaners

A variety of high-pressure cleaners and steam cleaners exist (Table 30). The smaller 'domestic' cleaners usually are mainly electricity-powered and mobile while industrial cleaners might be stationary as well and powered by gas, or liquid fuels.

In PRODCOM the category 28.29.22 includes "fire extinguishers, spray guns, steam or sand blasting machines and similar mechanical appliances, except for use in agriculture" [72]. Apparently, high pressure washers are part of category 28.29.22.30 'Steam or sand blasting machines and similar jet-projecting machines (excluding fire extinguishers, spray guns and similar appliances)'.[9] Classification in the CN2009 database is more detailed [73]. Here, steam or sand blasting machines and similar jet-projecting machines have a sub-group 'water cleaning appliances', thus we assume that high-pressure washers are a part of 28.29.22.30 in PRODCOM (Table 31).

Table 30 Typical high pressure cleaners and steam cleaners

Type of cleaner	Sector	Temperature	Mobile/ stationary	Power supply	Typical technical parameters
High-pressure cleaner	Domestic	Cold	Mobile	Electricity	1-3 kW, 300-500 l/h
				Gasoline	2-4 kW, 420-470 l/h
		Hot	Mobile	Electricity	2-5 kW, 400 l/h
	Industry	Cold	Mobile	Electricity	3-7 kW, 230-900 l/h
				Diesel/Gasoline	4-15 kW, 650-1000 l/h
			Stationary	Electricity	4-6 kW, 600-1300 l/h
		Hot	Mobile	Electricity	5-6 kW, 300-750 l/h
				Diesel/Gasoline	4-14 kW, 450-1200 l/h
				Fuel oil	3-6 kW, 350-800 l/h
			Stationary	Gas	6-8 kW, 5000-1200 l/h
				Diesel/Gasoline	6-8 kW, 5000-1200 l/h
Steam cleaner	Domestic	---	Mobile	Electricity	1.4-2.3 kW
	Industry	---	Mobile	Electricity	2-30 kW

Table 31 Classification of high-pressure cleaners and steam cleaners in PRODCOM and CN

Classification	Number	Label
PRODCOM 2009	28.29.22	Fire extinguishers, spray guns, steam or sand blasting machines and similar mechanical appliances, except for use in agriculture
	28.29.22.20	Spray guns and similar appliances
	28.29.22.30	Steam or sand blasting machines and similar jet-projecting machines (excluding fire extinguishers, spray guns and similar appliances)
CN2009	84.24	Mechanical appliances (whether or not hand-operated) for projecting, dispersing or spraying liquids or powders; fire extinguishers, whether or not charged; spray guns and similar appliances; steam or sandblasting machines and similar jet projecting machines
	84.24.10	Fire extinguishers, whether or not charged
	84.24.20	Spray guns and similar appliances
	84.24.30	Steam or sandblasting machines and similar jet projecting machines

[9] See http://www.faqs.org/rulings/rulings2001HQ964637.html or http://www.faqs.org/rulings/tariffs/84243090.html.

Classification	Number	Label
		• Water cleaning appliances, with built-in motor 84.24.30.01 with heating device 84.24.30.05 Other, of an engine power not exceeding 7.5 kW 84.24.30.09 Other, of an engine power exceeding 7.5 kW • Other machines 84.24.30.10 compressed air operated 84.24.30.90 other
	84.24.90	Parts

Sources: [72,73]

According to PRODCOM data, the production in the EU-27 in 2008 was about 146 Mio. units of 'spray guns and similar appliances' with a value of 214 Mio. Euro (Table 32). Production of steam or sand blasting machines is 6 Mio. units and 1 064 Mio. Euro in 2008.[10]

Table 32 PRODCOM data 2008 on high pressure cleaners and steam cleaners

PRODCOM category	PRODCOM label	Production EU-27 in Mio. EUR	Production EU-27 in Mio. units	Import in Mio. EUR	Export in Mio. EUR
28.29.22.10	Fire extinguishers	668	16	115	163
28.29.22.20	Spray guns and similar appliances	214	146	196	154
28.29.22.30	Steam or sand blasting machines and similar jet-projecting machines (excluding fire extinguishers, spray guns and similar appliances)	1064	6	153	536
28.29.22.40	Other mechanical appliances for projecting, dispersing or spraying	1920	168	283	635

Source: [72]

External trade data suggests that the EU-27 is a net importer of high-pressure washers in terms of units (Table 33). Total import amounts to approx. 2.4 Mio. units and export is about 2 Mio. units while production was estimated at approximately 6 Mio. units. Apparent EU-27 consumption thus is 6.4 Mio. units annually. However, import and export in terms of monetary value might not match PRODCOM data exactly. PRODCOM data suggest a production value of 1 060 Mio. Euro imports of 53 Mio. Euro and exports of 536 Mio. Euro [72]. According to [73], imports of water cleaning devices are 87 Mio. Euro and exports are 256 Mio. Euro. The difference between the classifications can be explained by the fact that PRODCOM includes also steam- and sandblasting machines.

If we compare unit values, we arrive at 20 to 1200 Euro per unit according to the external trade database and about 1.5 Euro/unit for spray guns and 180 Euro/unit for cleaners according to PRODCOM.

We assume increasing stock of water-cleaning appliances in the EU-27. Average lifespan is estimated to be 10 years. Apparent consumption was estimated at 6.4 Mio. units per year. Assuming a stock growth of 10 % this corresponds to a stock of 64 Mio. units in the EU-27. Compared to about 195 million households in the EU-27, this would mean that every third household owns a

[10] Kärcher, for example, sold about 6.4 Mio. units worldwide in 2008.

water cleaning appliance. This might seem to be an overestimation, however data for Austria show that there, the household ownership is 25 % on average and already 40 % in rural areas [74].

Table 33 External trade data on high pressure cleaners and steam cleaners in 2008

CN category	CN label	Import in EU-27		Export from EU-27	
		Mio. EUR	Pcs	Mio. EUR	Pcs
84.24.30.01	Water cleaning appliances with built-in motor, with heating device	12.0	558000	63.9	152 653
84.24.30.05	Water cleaning appliances with built-in motor, without heating device, of an engine power ≤ 7.5 kW	50.2	1425844	158.8	1 783 897
84.24.30.09	Water cleaning appliances with built-in motor, without heating device, of an engine power ≥ 7.5 kW	24.8	392047	33.4	27 968
Total		**87.1**	**2 375 891**	**256.1**	**1 964 518**

Source: Eurostat external trade database [73]

To estimate the energy and water use due to high-pressure cleaners, we have not only to assess the EU-27 stock, but also the utilisation frequencies, and specific water and energy consumption. A quick research in internet forums revealed that owners use their high-pressure equipment between once per year (cleaning of terrace in autumn) and 30 times (heavy user owning an off-road motorcycle and cleaning the cages of pets) per year.[11] In this paper, we estimate an average use of once per month and 1 hour per use, in total 12 h per year.

As said before, the water consumption of high-pressure cleaners is assumed to be about 400 l/h and energy use is 4 kW per hour. Thus, total water use is 307 Mio. m^3 per year. The energy use is about 11.1 PJ in the EU-27. In Section 5.3.5, we estimated the water use due to domestic high-pressure cleaners to be about 300 Mio. m^3 and energy use to be about 10 PJ (Table 26) which confirms that the order of magnitude of water and energy use due to high-pressure cleaners we calculated is reasonable.

Concerning the water and energy saving potential of high pressure cleaners, no reliable figures are available. Given the different models as described in Table 30, the water use varies between 300 and 1 300 litres per hour. Under the assumption that the average permanent water flow of a (garden) hose is around 1200 litres per hour and assuming that high pressure cleaners only consume water when being triggered, a potential for water consumption certainly exists. However, this is compensated to a certain extent by the energy consumption of high pressure cleaners, which in the case of (garden) hoses is zero (pumping energy to bring water to the spot is the same for both, as high pressure cleaners usually are connected to a hose).

5.4.2 Car wash facilities

Information on car-wash facilities and car-wash behaviour is scarce. Several different professional car-wash facilities exist on the market:

- Hand car wash facilities (vehicle washed by employees);
- Self-service facilities (coin-operated);

[11] See e.g.: http://newsgroups.derkeiler.com/Archive/De/de.rec.heimwerken/2008-03/msg00228.html or http://www.werkzeug-news.de/Forum/ftopic14001.html.

- In-bay automatics (stationary vehicle);
- Tunnel washes (conveyor);
- Mobile wash systems.

In Germany currently 1500 tunnel wash systems, 12 000 in-bay automatics and more than 2 400 self-service facilities exist [75]. On average, one can assume that the water use of these facilities is about 500 l per car [76]. However, about 90 % of the water used is recycled and reused [75]. Thus, water consumption in Germany is 50 l per car. [76] estimates the water use in professional car wash facilities in the US to be between 15 and 43 gallons per vehicle (57 to 163 litres per vehicle). The water rating scheme for car-wash facilities in Australia proposes a consumption of over 200 l per car as non-rated and 40 l per car as 5-star rated [77].

Car-washing at home consumes between 70 and 150 l per car according to [75] and between 180 and 220 l according to [78].

A study analysed the car-wash methods in different EU countries (Figure 14). On average, 39 % of the Europeans wash their car themselves by hand at home [79], while in the US, 38 % of car owners said in a survey that they would use home wash most often [80]. 31 % use an automatic car-wash facility and 17 % use independent car-washes. In Germany, 60 % of all car owners use professional car-wash services [81].

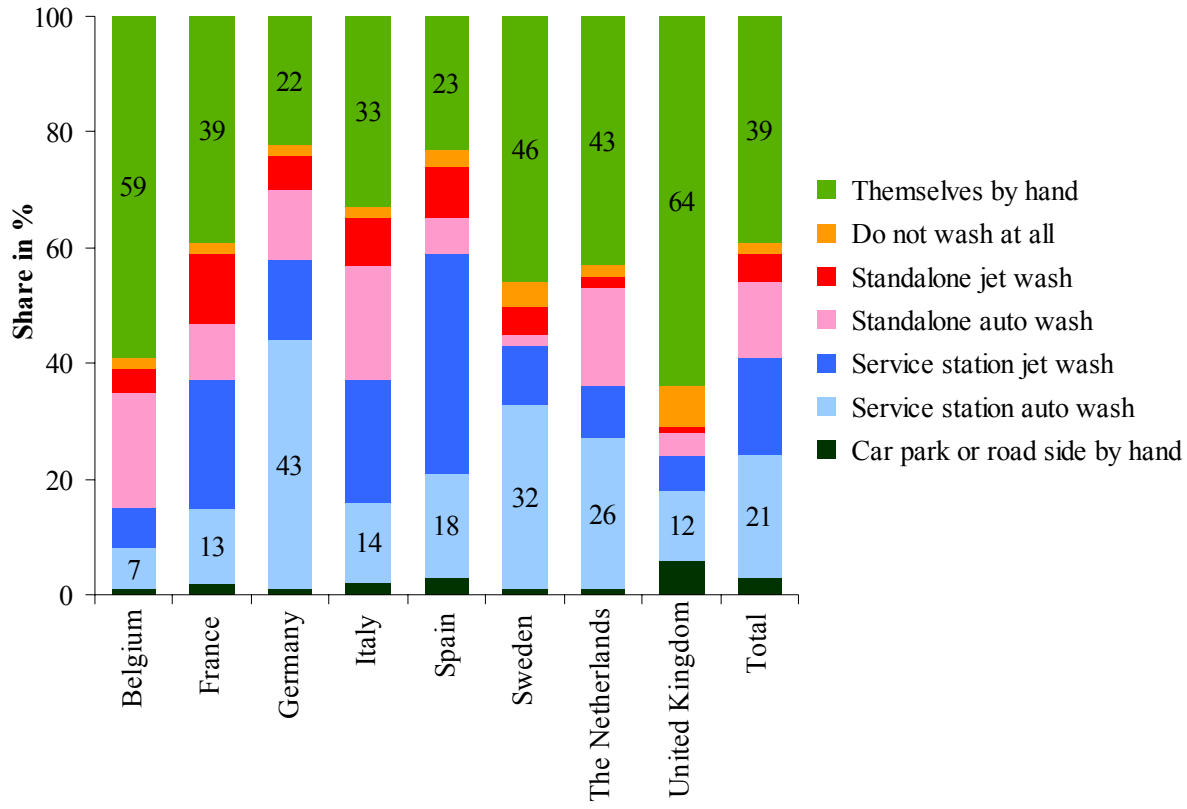

Figure 14 Car-wash method popularity in selected countries in the EU
Share of responses by wash type used most often in the last 12 months. Source: [79]

Car-wash frequency differs across Europe. In Germany, cars were washed on average eight times per year [82]. In Spain, cars are washed almost 14 times per year [79]. In Europe, on average, a car is cleaned 10 times per year [79].

To calculate water and energy use we assume 10 car washes per car in Europe. The European car fleet is composed of about 220 Mio. cars [83]. Thus, 2 200 Mio. car-washes are performed annually. We assume a manual car-wash at home consuming 150 l and a 'professional' car-wash using 50 l of water. As 40 % of car-washes a re done at home by hand, the water consumption is 132 Mio. m^3. The car-washing in professional facilities consumes 66 Mio. m^3 annually.

Energy consumption in a professional facility is 0.6 kWh per car-wash [84]. Total energy use in Europe thus equals about 2.9 PJ per year.

For the manual car-wash at home we assume a water temperature of 29 ºC. We estimate that the water has to be heated from 19 ºC to 29 ºC, thus a heating of 10 ºC is required (see Section 5.3.5). For 1 l of water this means that 41.8 kJ of energy is needed.[12] As 132 Mio. m^3 water are used, the energy consumption is 5.5 PJ annually.

Total energy use for car washing is about 2 % of energy use of washing machines or energy use due to shower heads. Water use for car washing is about 3 % of water used for washing machines or about 5 % of water used for showering (see Table 26).

The improvement potential for water and energy use of car-washing was estimated at 20 % (1.7 PJ of energy and 39.6 Mio. m^3 of water).

6 Ranked list of suitable product groups

During the preparation of this discussion paper, it has become clear, that there is a lack of consistent and reliable data regarding water use in different sectors. Even more difficult, concerning the disaggregation to individual WuP, there is no data available.

Thus, the results of the present analysis should be considered a first estimate, and are associated with a high degree of uncertainty. However, the present paper allows identifying the water-using product groups that might be suitable for an application under the ecodesign directive.

Table 34 shows the relevance of the water-using products with respect to the environmental performance (water and energy use) and improvement potential in the EU-27as well as the coverage by existing legislation.

Table 34 Assessment of water-using products with respect to legislation, environmental relevance and technical improvement potential

Sector	Water-using product	Legislation[a)]		Water and energy use		Improvement potential[b)]	
		EuP/ErP	Covered	Mio. m^3	PJ	Mio. m^3	PJ
Agri-culture	Trickle (dripper)	Y	N	5 823	n.a.	291	n.a.
	Spray (sprinklers, hose-reel, centre pivot)	Y	N	22 451	n.a.	3 350	n.a.
	Surface flow (furrow, border)	N	N	37 478	n.a.	n.a.	n.a.
Urban	Faucet	Y	N	12 660	706	2 067	141
	Showerhead	Y	N	4 669	260	934	52

[12] Specific heat capacity is 4.1813 J per g and K according to http://en.wikipedia.org/wiki/Specific_heat_capacity.

Sector	Water-using product	Legislation[a)]		Water and energy use		Improvement potential[b)]	
		EuP/ErP	Covered	Mio. m^3	PJ	Mio. m^3	PJ
	Bathtub	Y	N	4 669	260	---	---
	Toilet	N	N	17 198	---	3 440	---
	Urinal	N	N	1 672	---	334	---
	Bidet	Y	N	n.a.[e)]	n.a.	n.a.	n.a.
	Swimming pool	Y	N	79	n.a.	---	n.a.
	Sprinkler	N	N	236	---	n.a.	---
	Water heater	Y	Y[c)]	n.a.	n.a.	n.a.	n.a.
	Central heating boiler	Y	Y[c)]	n.a.	n.a.	n.a.	n.a.
	Central heating combi boiler	Y	Y[c)]	n.a.	n.a.	n.a.	n.a.
	Evaporative air cooler	Y	Y[c)]	n.a.	n.a.	n.a.	n.a.
	Washing machine	Y	Y[c)]	4 125	292	825	44
	Dishwasher	Y	Y[c)]	589	149	236	15
	Fire sprinkler	Y	N	n.a.	n.a.	n.a.	n.a.
Industry	Open once-through cooling system	Y	Y[d)]	18 090 in total, all cooling systems aggregated	n.a.	3 618[f)] in total, all cooling systems aggregated	n.a.
	Open recirculating cooling system	Y	Y[d)]				
	Closed circuit wet cooling system	Y	Y[d)]				
	Open hybrid cooling	Y	Y[d)]				
	Closed hybrid cooling	Y	Y[d)]				
	Water heater	Y	Y[c)]	3 360 in total, all boiler systems aggregated	n.a.	672[f)] in total, all boiler systems aggregated	n.a.
	Central heating boiler	Y	Y[c)]				
	Central heating combi boiler	Y	Y[c)]				
	Firetube boiler	Y	Y[d)]				
	Watertube boiler	Y	Y[d)]				
	Vapour generating boiler	Y	Y[d)]				
	Superheated water boiler	Y	Y[d)]				
	Process-water chemicals	n.a.	Y[d)]	3 152	n.a.	315[g)]	n.a.
	Process-water coke and refinery	n.a.	Y[d)]	116	n.a.	12[g)]	n.a.
	Process-water pulp and paper, printing	n.a.	Y[d)]	4 902	n.a.	490[g)]	n.a.
	Process-water metal fabrication and processing	n.a.	Y[d)]	220	n.a.	22[g)]	n.a.
	Process-water food	n.a.	Y[d)]	1 057	n.a.	106[g)]	n.a.
	Process-water textiles	n.a.	Y[d)]	1 245	n.a.	125[g)]	n.a.
	Process-water other sectors	n.a.	n.a.	3 152	n.a.	315[g)]	n.a.
	Fire sprinkler	Y	N	104	n.a.	---	n.a.
	Other	n.a.	n.a.	1 947	n.a.	195[g)]	n.a.
Hori-zontal	High-pressure & steam cleaner	Y	N	299	10	60	2
	Car-wash facilities	Y	N	198	8	40	2

a) *Legend: Y: yes. N: no; b) technical potential as opposed to technological change (e.g. switching from on irrigation system to another or replacing bathing by showering) or behavioural changes (e.g. taking a shower less often); c) covered by EuP implementing measure; d) covered by other legislation, e.g. BREF documents; e) n.a.: not analysed; f) assuming a reduction potential of 20 %; g) assuming a reduction potential of 10 %

To arrive at a ranked list of WuP that could be candidates for application of the ecodesign directive, we removed all WuP that are non-EuP or non-ErP from the list. In addition, we excluded all WuP that are already covered by Implementing Measures and those for which preparatory studies have been performed. The short list of WuP is shown in Table 35.

Table 35 Qualitative assessment of water-using products with respect to environmental relevance and technical improvement potential

Sector	Water-using product	Legislation[a)]		Water and energy use		Improvement potential[b)]	
		EuP/ErP	Covered	Water	Energy	Water	Energy
Agri-culture	Trickle (dripper)	Y	N	XX	n.a.	O	n.a.
	Spray (sprinklers, hose-reel, centre pivot)	Y	N	XX	n.a.	XX	n.a.
Urban	Faucet	Y	N	XX	XX	XX	XX
	Showerhead	Y	N	XX	X	XX	X
	Bathtub	Y	N	XX	X	--	--
	Bidet	Y	N	-	-	-	-
	Swimming pool	Y	N	--	--	--	--
	Fire sprinkler	Y	N	-	-	--	--
Industry	Open once-through cooling system	Y	Y[d)]	XX in total, all cooling systems aggregated	n.a.	XX in total, all cooling systems aggregated	n.a.
	Open recirculating cooling system	Y	Y[d)]				
	Closed circuit wet cooling system	Y	Y[d)]				
	Open hybrid cooling	Y	Y[d)]				
	Closed hybrid cooling	Y	Y[d)]				
	Firetube boiler	Y	Y[d)]	X in total, all boiler systems aggregated	n.a.	X in total, all boiler systems aggregated	n.a.
	Watertube boiler	Y	Y[d)]				
	Vapour generating boiler	Y	Y[d)]				
	Superheated water boiler	Y	Y[d)]				
	Process-water chemicals	n.a.	Y[d)]	X	n.a.	O	n.a.
	Process-water coke and refinery	n.a.	Y[d)]	-	n.a.	--	n.a.
	Process-water pulp and paper, printing	n.a.	Y[d)]	XX	n.a.	O	n.a.
	Process-water metal fabrication and processing	n.a.	Y[d)]	O	n.a.	--	n.a.
	Process-water food	n.a.	Y[d)]	X	n.a.	-	n.a.
	Process-water textiles	n.a.	Y[d)]	X	n.a.	-	n.a.
	Process-water other sectors	n.a.	n.a.	X	n.a.	O	n.a.
	Fire sprinkler	Y	N	-	--	--	--
	Other	n.a.	n.a.	X	n.a.	O	n.a.
Hori-zontal	High-pressure & steam cleaner	Y	N	O	-	-	-
	Car-wash facilities	Y	N	-	--	--	-

a) *Legend: Y: yes. N: no; b) technical potential as opposed to technological change (e.g. switching from on irrigation system to another or replacing bathing by showering) or behavioural changes (e.g. taking a shower less often); c) covered by EuP implementing measure; d) covered by other legislation, e.g. BREF documents; e) n.a.: not analysed; f) assuming a reduction potential of 20 %

Greatest water use in products can be found in urban WuP (faucet, showerhead, and bathtub) and agricultural WuP (e.g. sprinklers). WuP for cooling in industry show high water use in total, however, this has to be disaggregated to the individual WuP; a task that could not been done within this analysis. Also, industrial water use by boilers is high in total. For individual industry sectors, water use is relatively high (e.g. pulp and paper). Again, a disaggregation to individual WuP could not be done in the context of this discussion paper. From the perspective of water and energy use, horizontal technologies as high-pressure & steam cleaning or car-washing are almost irrelevant.

If we look at the water saving potential, the ranking is as follows: highest saving potential is due to irrigation by sprayers (sprinklers, hose-reel, and centre pivot), faucets, and showerheads. Also, industrial cooling shows a high reduction potential. However, with respect to agriculture, there seem to be measures that lead to a higher saving potential compared to technological improvements of individual irrigation products, e.g. improved irrigation management, optimised mix of existing technologies or a comprehensive pricing scheme (see Table 9). These measures would probably

generate less administrative cost and burden to farmers than the development of implementing measures. In industrial applications, apparently, water efficiency is already high, especially in industries that show high water use, as water as a cost factor is already taken into account in process efficiency improvements. In addition, the industry sectors that use most water are already covered by BREF documents which address water use.

To conclude, we would suggest the following WuP product group as the most suitable candidates for the application of the ecodesign directive:

- faucets;
- showerheads.

As an alternative, they could be analysed together in one product group „sanitary tapware" which would include the two products faucets and showerheads. A second product group would then still to be defined. To this end, further discussion is needed, complemented with a more in-depth analysis of water using products in the different sectors.

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