ECOTAPWARE

Task 5: Taps and Showerheads – Best Available Technology (BAT)

September 2011

JRC EUROPEAN COMMISSION

ipts stitute for ospective chnological Studies

AEA

Table of Contents

1 Introduction

The Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with support from AEA, has conducted a pilot study to develop a joint evidence base and related product policy measures in the area of water using products for the European Commission's Directorate General for the Environment.

Further details regarding the project are available through the following website:
http://susproc.jrc.ec.europa.eu/ecotapware/index.html

This report supports Task 5, and considers Best Available Technology (BAT) and Best Not Yet Available Technology (BNAT) for taps and showerheads. The term “Best” is taken to mean the most effective in achieving a high level of environmental performance of the product. “Available” technology is taken to mean that developed on a scale which allows implementation for the product, under economically and technically viable conditions, taking into consideration the costs and benefits. This applies whether or not the technology is used or produced inside the EU Member States, so long as it is reasonably accessible to the product manufacturer. On the other hand, “Not yet” available technology is taken to mean that not yet developed on a scale which allows implementation for the relevant product, but that is subject to research and development.

The environmental assessment (See Task 4 Report) indicated that the water flow rate of taps and showerheads, together with the associated energy use for heating water, are the key environmental impacts. The water saving function of taps and showerheads has therefore been the focus of the technologies identified and described in this report.

In order to assess BAT and BNAT input from stakeholders was requested through the second questionnaire; limited information was forthcoming. A separate request for information was made to stakeholders in April 2011 to which four responses were received. Further direct correspondence was undertaken with those stakeholders who responded, and their input has been included in this report where appropriate.

When developing ecolabel criteria and GPP specifications it is important to understand the technology available on the market for the product group i.e. taps and showerheads and any potential barriers to its uptake. This understanding is needed so that criteria can be set at a level to differentiate the top performing projects, typically the top 10-20% of the market. It will also ensure the criteria do not become obsolete in a short space of time as a result of any significant technological developments that would potentially cause a shift in product standards available on the market.

The information and understanding provided by this report will contribute to the criteria development process by identifying trends in the technology for taps and showerheads and provide information on forthcoming developments, where appropriate, to help inform the level at which criteria, such as flow rate should be set.

Water saving functions include measures to directly reduce and control flow rates e.g. flow regulators, but also product features aimed at assisting the end user to reduce their water use e.g. water brakes which are discussed in detail in section 3.1.4. Some of the technologies described have been available for many years as the industry has been developing and implementing innovations to reduce flow rates. Drivers behind these developments are discussed in Section 2.

Following an overview of general trends and drivers, the report provides a description of different technologies, together with relevant product examples available on the market. This is followed by a discussion of the outcome of the review of technologies, including their implications for setting ecolabel criteria and GPP specifications.

2 General Trends and Drivers

Over the last 10-15 years there has been an increasing focus on water efficiency generally across different industry sectors and through different uses. This includes the use of water through taps and showerheads, both from a product perspective and the behaviour of end users. This increased focus on water efficiency in general is a result of a number of key consumer and business drivers:

- The cost of supplying water is increasing and these costs are passed onto consumers in the form of higher water bills. In response to this consumers and businesses are keen to identify and implement measures that enable them to reduce their water bills.

- Other utility costs are also increasing, for example gas and electricity. The associated energy consumption for heating water is increasingly recognised by both businesses and consumers as a potential area for saving, not just from an environmental perspective, but also cost savings.

- Support to promote product innovation and development in the area of water efficiency through schemes such as the UK Enhanced Capital Allowance scheme, which enables businesses to claim tax reductions on investments on technologies and products that encourage sustainable water use.

- Increased provision of product information through schemes such at the Water Technology List, product labelling schemes and national ecolabels increase awareness and consumer/business understanding of the differences in products.

- Consumer awareness of the environment and the impact they have on it, including their water use, is increasing. This has resulted in many consumers sourcing products that help them to achieve a more sustainable life style.

- Businesses are increasingly recognising the risk posed by water scarcity to their operations, especially those that utilise large volumes or where water is integral or the limiting factor in their processes. More sustainable water use will help reduce overall water consumption and minimise exposure to such risks.

- Businesses are increasingly aware of their environmental impacts and profile and the commercial benefits from improved reputation through increased Corporate Social Responsibility.

- Regulation and Government policy, such as the Code for Sustainable Homes and the Building Regulations in the UK.

- Identification of business opportunities by front runners, for example in the development of particular technologies to give them a competitive advantage.

In addition to water efficiency, other drivers will also influence the innovation and design of tap and showerhead products:

- Consumers have increasingly busier lifestyles and like products that are easy to install and use, offering high levels of convenience.

- Consumers have expectations of product performance, for example comfort levels when showering, which if not met will result in them looking at alternative products that meet their requirements.

- Products may be required to undertake different types of functions, for example hand washing or vessel filling leading to products that offer consumers increased flexibility in how the product can be used.

- User behaviour is an important aspect of improving water efficiency of taps and showerheads. The products need to be installed correctly, used in the correct way and for their intended design purpose to operate at their optimum. Additional features may be included within the design of the product to help direct consumer behaviour or information provided with the product itself.

- Health and safety issues need to be considered, in particular when dealing with the delivery of hot water, with the need to take issues such as scalding and legionnaire's disease into account.

These drivers have resulted in a number of product innovations over the years in order to improve water efficiency across a wide range of products and will continue to drive future innovation. This includes technologies specific to taps and showerheads outlined in Section 3.

3 Technology Description and Product Examples

3.1 Introduction

The following technologies / features have been identified through the research undertaken for this project and feedback from industry stakeholders as solutions to reduce water use through taps and showerheads:

- Aerators
- Flow Regulators
- Ecobutton
- Taps with Water Brakes
- Energy Saving Features
- Showerhead Design and Spray Patterns
- Sensor Taps
- Automatic Shut Off Taps (Push Taps)

These different technologies can often be used in products on their own; however, the assessment of different technologies and the products they are included in has shown that it is common for two of more of the features to be included within a product. This has been highlighted in the discussion where appropriate.

3.1.1 Aerators

An aerator entrains air into the water stream which breaks the water stream into many small droplets, providing an effective cleansing function but with less water. The resulting water stream is softer to touch and is non-splashing.

Aerators do not necessarily control the flow rate by themselves. With standard aerators the flow will increase as the pressure increases, however, aerators are commonly combined with a flow regulator producing a constant flow rate regardless of pressure fluctuations (see Figure 1). These are manufactured to offer a range of flow rates, for example the product shown in Figure 1 can operate at 7 l/min which is more than adequate for hand washing.

Figure 1: Example of a pressure compensating aerator [1]

Aerators can be fitted to both taps and showers. Tap aerators are integrated into the spout (with or without a flow regulator) and are often used in homes with low water pressure in order to increase the perceived water pressure and provide a flow straightening function. Water efficient taps commonly feature both an aerator and flow regulator, and whilst aerators can be used in domestic and commercial premises they are more commonly used for domestic applications. Further consideration of flow regulators in included in Section 3.1.2.

[1] Neoperl product brochure and Water and Energy Saving presentation (as supplied by manufacturer)

An example of a basin mixer fitted with an aerator and flow regulator is shown in Figure 2.

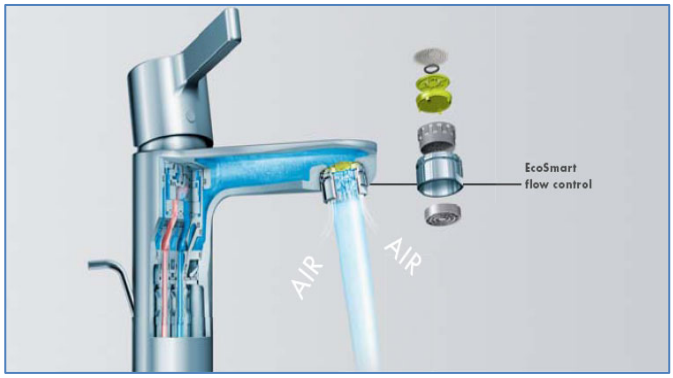

Figure 2: Example basin mixer (Metris S) fitted with an integrated aerator and flow regulator[2]

Products such as the example shown in Figure 2 can result in water and energy cost savings when compared to a conventional tap through reduced water use and the energy saving from reducing hot water use. Typical water and energy savings for this example product are shown in Table 1. These have been calculated by the manufacturer for a particular scenario, which also includes a figure for product payback. The payback periods indicate that for this example product there is an additional cost of products with an integrated aerator and flow regulator. The higher product payback period for the product with an electronic mixer indicates that the inclusion of an electronic mixer has a significant effect on price compared to the integrated aerator and flow regulator. Overall however the product payback periods of 7 or 20 months are relatively short given the overall lifetime of these products.

Table 1: Potential savings from a basin mixer fitted with integrated aerator and flow regulator [2]

	Conventional (13.5 l/min)	Hansgrohe EcoSmart (5 l/min)	Electronic mixer EcoSmart (5 l/min)
Water consumption (litres - 3 min per day approx)	40.5	15	15
Annual water consumption (litres) (based on family of four)	58,968	21,840	21,840
Annual cost of water (Euros), family of four (see note 1)	324	120	120
Annual savings in water costs (approx €)	**-**	**204**	**204**
Annual cost of oil/gas (Euros) to heat water (see note 2)	107	40	40
Annual savings in energy costs (approx €)	**-**	**67**	**67**
Total annual savings (approx €)	-	271	271
Product payback period (months)	-	7	20
Calculated Purchase Cost (See note 3) (approx €)	Will depend on the model purchased, range from T2/3 Report is €8-475	160	450

[2] http://www.hansgrohe.co.uk/cps/rde/xbcr//SID-29859371-C49536E6/uk_en/publications/UK/enUK_HG_EcoSmart_2010.pdf

Note 1: Average in Germany including waste water and base rate (approx. € 5.50/1,000 litres). Cost of water varies greatly in different regions.
Note 2: Energy required to increase the temperature of 1 litre of water by 1 degree Celsius: 1 kcal or 0.00116 kWh. Energy required to increase the temperature of 1 litre of water from 10 degrees Celsius (cold tap water) to 35 degrees Celsius (warm water temperature): 0.029 kWh/litre of water. Calculated with the energy formula on the basis of the general calculation principles according to the International System of Units (SI). Conversion from kWh to oil: 10 kWh = 1 litre of oil.
Note 3: Based on the annual savings and payback periods. Actual prices may vary from retailers.

The actual savings will depend on the pressure of the system the tap is used on, the price of water and electricity and the usage patterns/behaviour of the end users.

3.1.2 Flow Regulator

As noted in Section 3.1.1, aerators are often used in conjunction with a flow regulator. Pressure compensating flow regulators maintain a constant flow rate regardless of variations in line pressure. This provides improved system performance ensuring comfort for the end user at lower pressures as well as water and energy savings at high pressures.

The flow regulator is based on an elastomeric component which is deformed by increasing water pressure, which closes the water bypass area of a specifically designed flow regulator core/profile, see Figure 3.

Under static conditions (no flow, or low pressure) the elastomer is relaxed (position 1). Under dynamic conditions (flow) the elastomer subjected to the line pressure is compressed into the seating area which reduces the water passage (position 2). As the pressure increases the elastomer is compressed further into the seating area further reducing the water passage (position 3). As the line pressure decreases the elastomer relaxes and reopens the water passage (returning to positions 2 and 1).

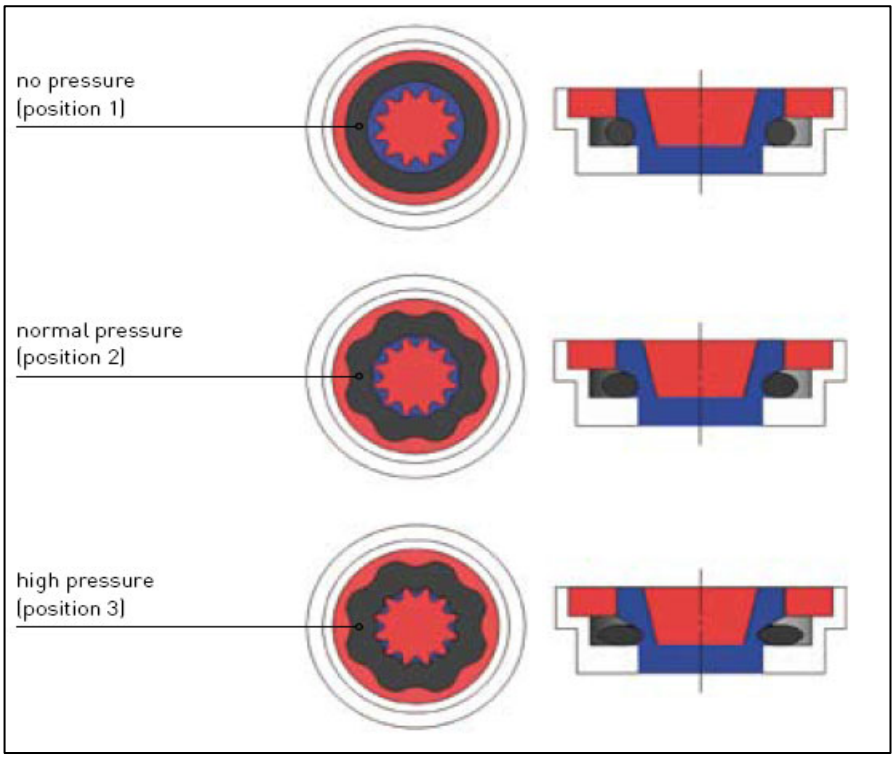

Figure 3: Flow regulator mechanism [3]

Flow regulators are manufactured to provide control over a range of pressure conditions (see Figure 4), enabling the user to choose the suitable model for a given situation. Standard regulators begin controlling the flow in a pressure range from 0.8 to 10 bar with special models developed for low

[3] Neoperl products brochure – flow regulators (supplied by manufacturer)

pressure installations as are typical, for example, in the UK and Ireland. The flow control function of low pressure regulators is initiated at a significantly earlier stage, and control flow at pressures as low as 0.25 bar.

A variation between a standard and low flow model of flow regulator are dual flow regulators, which allow the users to select two possible flow rates or two pressure ranges in one regulator housing combining low pressure applicability (requiring maximum flow at low pressures) with pressure compensating flow regulation at standard pressure ranges.

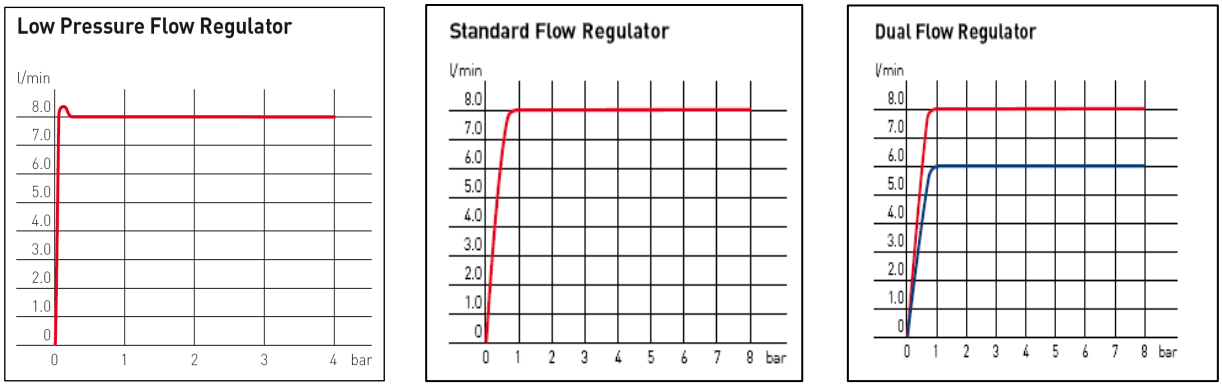

Figure 4: Performance of different flow regulator types for up to 8 bar pressure[4]

Flow regulators (Standard, Combined Function or Low Pressure types) can be designed to operate at different flow rates, depending on the tap or showerhead manufacturer's requirements. An indication of the range for flow rates for different regulator types are shown in Figure 5. There are a wide range of flow rates available, which can be incorporated into products. This highlights the importance on the installer/end user in choosing a product that is suitable for their pressure system i.e. high or low pressure and intended use. The ecolabel can play a role here through the User Information criteria by including requirements for products to clearly state which types of pressure systems they are suitable for, or the pressure range for which they are designed. It is also clear that flow regulators for the majority of applications exist.

[4] Neoperl products brochure – flow regulators (supplied by manufacturer)

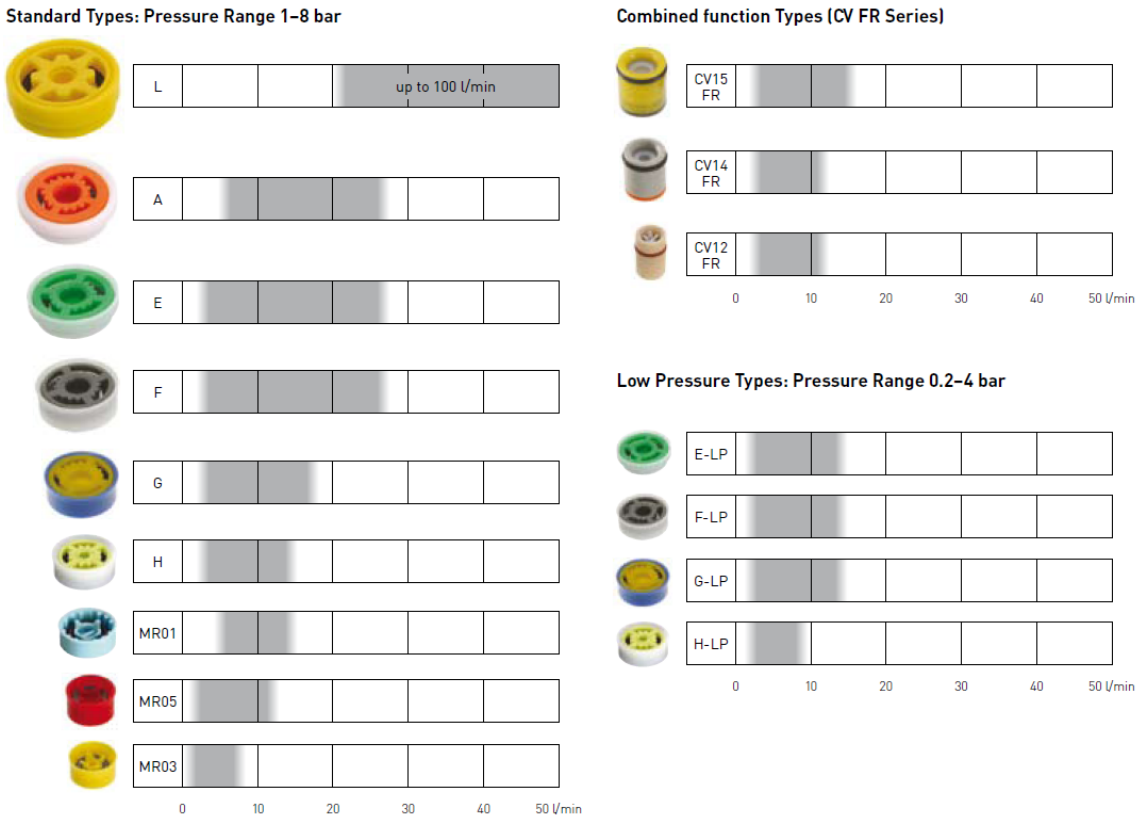

Figure 5: Flow regulator flow ranges [5]

Flow regulators can be removed for maintenance, replaced or upgraded, and can be accommodated in the inlet/outlet connections of an isolation valve or the ball of a quarter turn valve. As illustrated with the examples above, they are commonly inserted in taps and showers, built into the overall product design (see Figure 2) or available for retro fitting. In showers flow regulators can be fitted between the shower hose and the valve or wall outlet elbow, or between the shower head and arm. Flow regulators for both taps and showers can be fitted easily with simple tools and do not require plumbing expertise. This means that the end user can install and maintain flow regulators if they wish, therefore minimising the cost and therefore barriers to the use of this technology.

Flow regulators are inherently suitable for both domestic and commercial applications. In commercial and institutional installations where multiple taps are supplied by a single hot/cold water system, flow regulators can also help to improve the distribution of water, as well as reducing consumption.

Flow regulators play a prominent role in the design of water efficient taps and showers and have done so for at least the last decade. They are generally manufactured by companies that specialise in flow regulator design and supply them to the tap and showerhead manufacturers for them to incorporate them into their products. Whilst the technology is not new, it is important to highlight this option for controlling flow rates of products, as discussions with stakeholders have indicated that this is likely to continue to be one of the main technologies used in the coming years and will influence the capabilities of products to reduce flow rates further.

It is important to note that feedback from some stakeholders suggested that a flow rate of 4 litres per minutes is realistic, when other factors, for example health and safety and product performance are considered. The Task 4 report provides an account of various technical considerations that need to be taken into account when considering flow rates.

Using a product with a tap aerator and flow regulator or retrofitting such as product at a cost of less than €5.5 per tap, has a short payback period of just a couple of months based on water and

[5] Neoperl products brochure – flow regulators (supplied by manufacturer)

sewerage cost savings of around €16-17 per tap/year[6] (where a tap is used 20 times a day for 15 seconds) [7].

The low cost and quick payback of flow regulators in the example above has been re-iterated further by feedback from manufacturers. For example some indicated that flow regulators are included with products as standard, with their use dependent on the specific pressure of the system the tap is to be installed on, whereas other manufacturers offer taps with and without flow regulators and may charge a small premium for the inclusion of a flow regulator [8]. This is generally a small percentage of the overall product cost and has not presented a barrier to the technology uptake.

3.1.3 Ecobuttons

Ecobuttons are relatively new products, having been introduced to the market over the last couple of years. They allow the user to override a default lower flow rate setting in order to provide a higher flow rate delivery mode. The flow rate is controlled by an integrated flow regulator, which will operate on the same principles as outlined in Section 3.1.2.

When the user initially operates the tap the control device automatically restricts the water flow, but when the user wants more water, for filling the sink or other vessels, they press the ecobutton to release the full flow through the valve, providing increased flexibility of the product for the end user. Once the ecobutton is pressed the example product shown below will revert to its water saving mode once the water is turned off. Different models may require manual intervention to return to the water saving mode. It will be important that these products come with clear instructions regarding the different modes they can operate in and how to revert to the water saving mode to ensure they are used to gain maximum benefit by the end user.

These control devices can limit water use by 50% or more, but whilst the default lower flow rate may meet the criteria of water efficient technology schemes, such as the Water Technology List, the higher flow rates do not. This has implications on how to rate different products when implementing product labelling schemes, and is considered further in the discussion and conclusions section.

An example product is the Neoperl Ecobooster, which allows the user to switch from the default water saving mode to a boost-mode by pressing a button, see Figure 6 and Figure 7. The standard position (the default setting) is the water saving flow rate which is controlled by an integrated flow regulator. The boost position is the full flow setting and is fitted with an aerator. After turning off the water, the Ecobooster automatically returns to its standard water saving position.

The Ecobooster is easy to retrofit into existing applications. Domestic shower flow can be regulated to 8 litres per minute and 11 litres per minute (where boost full flow greater than 20 l/min with a non-restrictive shower head at 3 bar supply pressure). Kitchen and bathroom sink taps can be regulated to 5 litres per minute (where boost full flow greater than 17 l/min at 3 bar supply pressure). The boost mode is functional at low supply pressure (0.4 bar – 0.5 bar).

[6] Product cost and savings converted into Euros from Sterling using an exchange rate of 1 GBP = 1.11993 EUR
[7] Envirowise, 'Reducing water use in washrooms: taps', 2007, available online: http://envirowise.wrap.org.uk/england/Our-Services/Publications/EN664-Reducing-water-use-in-washrooms-taps.html
[8] For example Deva in the UK provide their Ikon Mono basin mixer (IKO113) without a flow regulator for £145.93, or with a 4 litre/min (IKO113/HSR4) or 2litre/min f(IKO113/HSR2) low regulator for £148.49 http://www.deva.org.uk/products/detail1/bathroomtaps1.php?category1=bt&range1=ikon&imageField4.x=38&imageField4.y=40

Figure 6: Ecobooster[9]

Figure 7: Example applications of the Ecobooster[10]

The Ecobooster costs approximately €25[11]. The payback period will be dependent on how much the user employs the default water saving position.

For showers ecobutton features have also been incorporated into the thermostatic valve shower controls, for example the Hansgrohe Ecostop[12]. This feature limits flow to 10 litres per minute, restricting flow by up to 50% (assuming a standard shower has a flow rate of 20 litres per minute at 3 bar pressure).

The Hansgrohe Ecostop is only fitted on showers with exposed thermostatic shower controls. When the shower is switched on it automatically restricts water flow by up to 50% to 10 litres per minute (assuming a standard flow rate of 20 litres per minute at 3 bar pressure). If more water is desired then the Ecostop button is pressed and turned to release the full flow of water through the valve, see Figure 8. The Ecostop feature is a mechanical valve, with a mechanical stop position at 50%, which can be overridden by pushing a button to allow the fully open position to be reached. It does not include a flow regulator.

[9] Neoperl Ecobooster datasheet (supplied by manufacturer)
[10] Neoperl Ecobooster datasheet (supplied by manufacturer)
[11] http://www.elcheapo.nl/kranen/neoperl/neoperl_ecobooster_kraan_m22_bi_waterbesparend_anti_kalk_02043498_145010696/
[12] http://www.aquabrand.com/prodlist/201-hansgrohe-ecostat-thermostatic-shower-mixer-taps-exposed

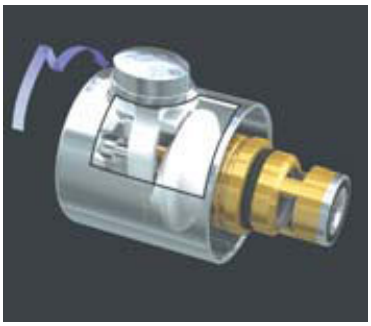

Figure 8: Ecostop Valve [13]

3.1.4 Taps with water brakes

Taps fitted with water-brakes, commonly known as 'click' or two stage taps are increasingly featuring in manufacturers' ranges. As the operating lever is raised the water flow increases until a flow rate of typically between 5 to 10 litres per minute is reached depending on the product design. At this point the user will feel a resistance to movement, and to open the tap any further requires additional force to overcome the brake. Once overcome, the lever will move as easily as before towards full flow, see Figure 9 as an example.

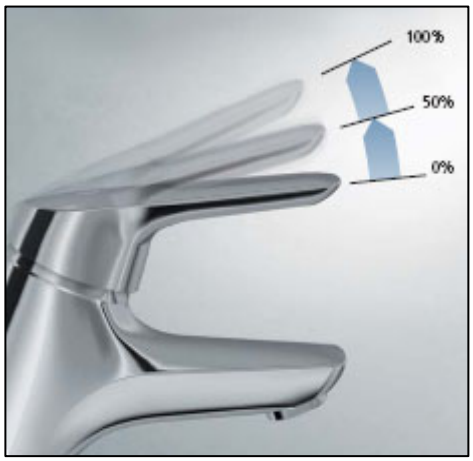

Figure 9: CeraMix Blue Eco tap[14]

In theory, water brakes can be fitted to pillar and rotary taps though they are normally only fitted to monoblock mixer taps. Currently click taps are generally set at 50% of maximum flow; however there is no physical reason why the break cannot be set to a different point. These products are rated at the maximum available flow rate by regulation in the UK[15] and as noted with Ecobuttons above the inclusion of these types of features will have implications for product labelling depending on how they are rated.

Although taps fitted with water brakes have potential to save water, they do have some limitations[16]. Their operation is pressure-dependent and they are generally only suitable for systems with pressure in excess of 1 bar, which is fine for the majority of mainland Europe, but is an issue for the UK and Ireland, although dual ceramic cartridge 'click' taps can operate under low pressure.

[13] http://www.hansgrohe.co.uk/cps/rde/xbcr//uk_en/publications/UK/Flow_limitors.pdf
[14] http://www.myidealbathroom.com/media/pdf/Brochure_Ceramix_Blue.pdf
[15] BMA Personal Communication
[16] http://www.water-efficient-buildings.org.uk/?page_id=1000

Taps with water brakes are often fitted with a flow regulator and an aerator, for example the Ideal Standard Ceramix Blue Eco model[17]. The flow limiter reduces water consumption between 9 litres per minute to 5 litres per minute, for example the CeraMix Blue ECO A5658AA has a maximum flowrate of 5 litres per minute, is fitted with an aerator and is WELL (Water Efficiency Label) certified as 4 Stars, Class A. All basin models are equipped with a **hot water limiter** to reduce the risk of scalding, which is a key consideration when thinking about reducing flow rates, which can increase the scalding risk. The hot water limiter is a special ring assembly within the taps cartridge, which can be adjusted by the installer or end user to set the temperature of the hot water delivered. The water will only be delivered at the temperature set if the supply conditions i.e. the input water temperature and pressure remains constant. In addition to the safety aspect of the hot water limiter, it will also result in energy savings if the lower temperature settings are used.

This model costs approximately €210[18], which compares to the price range of €8 – €475, with an average of €241 identified in the Task 2/3 Report for monobloc basin taps. In addition the manufacturer has estimated average savings up to €430 per year; the breakdown of estimated water and energy savings are shown in Figure 10[14]. These savings are based on the manufacturer's scenario of a family household of four people using a single basin fitting, and an average water price: 5.5€/m^3 and average energy price 0.75€/l).

Based on the above product price (€210) and cost savings identified for a family of four (€430) the product payback for this example would be approximately 5 months.

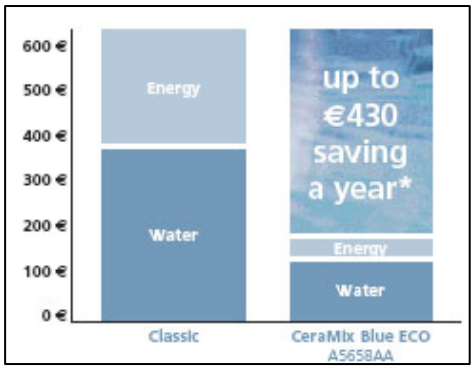

Figure 10: Potential savings from CeraMix Blue Eco tap[14]

Details of a second example have been provided as part of the stakeholder feedback, which also includes an energy saving aspect as well a water saving feature. The Villeroy and Bosh Nautic energy and water saving single handle mixer taps (see Figure 11) operate with the water-saver function providing graduated control of water flow by means of a special spring mechanism. The tap also includes an energy-saver function. During normal operation, the tap fitting delivers cold and warmed water; hot water flows only when the lever is intentionally moved to the left. The mixer lever automatically returns to an "energy saving mode" with a lower water temperature and flow, and is reported as achieving energy savings of around 40 to 50 percent.

[17] http://www.myidealbathroom.com/products/ceramix_blue.php

[18] http://www.reuter-badshop.com/ideal-standard-ceramix-blue-basin-mixer-with-flow-rate-limiter-p308504.php

Figure 11: Energy and water saving single handle mixer tap

Information provided by the manufacturer indicates that by replacing old mixers in kitchens, washbasins and showers, a small household or apartment is estimated as saving approximately 1,000 kWh energy annually, and about € 1,000 over 15 years. Using the energy costs quoted, The information provided by the manufacturer[19] shows a large household consuming 5,000 kWh energy for its hot water is estimated to save about 1,600 kWh annually with total savings of approximately € 1,750 over 15 years. The breakdown of estimated water and energy savings are shown in Figure 12. Assuming the product price for the energy and water saving mixer is approximately €750, as shown in Figure 12, the product payback period would be approximately 6.4 years, based on savings of €1,750 over 15 years.

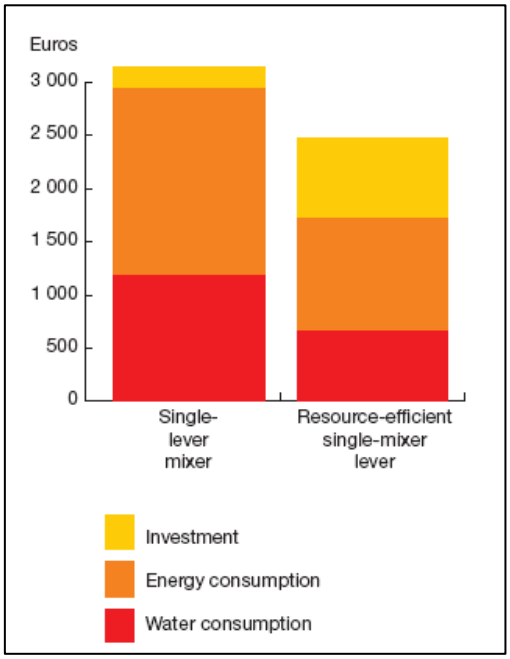

Figure 12: Estimated savings from energy and water saving single handle mixer tap[19]

Figure 12 shows that a conventional mixer is cheaper to buy, but more expensive to use, whereas the resource-efficient taps cost more to purchase, but have cheaper operational costs. Using information provided by manufacturer, comparing the costs of conventional and resource efficient taps over a typical 15 year lifetime for a household shows that three regular taps cost € 3,225 to purchase and use (assuming 2,500 kWh and 67 cubic meters of water consumed), whereas the corresponding cost for resource-efficient mixers is € 2,225 (where consumption is 1,500 kWh and 37 cubic meters of water annually). All costs include:

- investment at 4% real rate of interest
- energy consumption (€ 0.07 per kWh)
- water consumption (€ 1.56 per cubic meter)
- VAT

This demonstrates the importance of understanding the life cycle costs of the products, before making purchasing choices. The issue of life cycle costs is examined in more detail in the Task 4 report.

3.1.5 Showerhead design

The design of a shower head can affect its water consumption by controlling the flow and spray pattern and therefore the amount of water used. Low flow shower heads generally entrain air into the

[19] Save Energy with efficient tapware brochure/article, Swedish Energy Agency (Supplied by stakeholder)

water and will often include a flow restrictor, the same as those described above in the context of taps. Again, as seen with different tap designs, there is often a mixture of features and technology included in a product to achieve its intended design purpose.

Aeration in showerheads assists in the water appearing more voluminous to the shower user. Low-flow shower heads are not always suitable in buildings with low water pressure for satisfactory user experience and they are not suitable for use with electric showers because the water can overheat. A lower flow rate means the water will stay in contact with the heating element for longer, resulting in overheating. Some products include safety features to prevent this from occurring, which results in the heating elements switching off and any remaining hot water being flushed from the system if the flow is too low and the water gets too hot.

Hansgrohe utilise both aeration and flow regulators in their water efficient shower ranges (see Figure 13). To use water more effectively, about 3 litres of air is drawn in through the entire spray disc and mixed together with each litre of inflowing water, which results in the water drops becoming more voluminous, lighter and softer. The combination of the flow limitation, special spray jets and the mixing of water with air (which Hansgrohe term as their EcoSmart technology) reduce water consumption down to either 6 litres per minute (Crometta 85 Green handspray) or 9 litres per minute (Raindance).

Figure 13: EcoSmart Technology[20]

Based on information from the manufacturers marketing literature, the typical water and energy savings that can be achieved for the products with EcoSmart compared to the same product without EcoSmart technology (as estimated by the manufacturer) are shown in Table 2.

Table 2: Typical savings and payback periods[21]

	Annual savings Raindance S 150 AIR EcoSmart*	Annual savings Crometta 85 Green*
Water	approx. 24,024 litres	43,680 litres
CO_2	approx. 180 kg	approx. 326 kg
Cost of water and energy	approx. 181 €	approx. 329 €
Product payback period in months	6	1

*Compared to the same product without EcoSmart technology for a family of four in Germany in 2009.

It is worth noting that the product payback times are relatively short, and although this will change depending on variations in end user behaviour, typical savings indicate that differences in product price should not be prohibitive if life cycle costs are considered.

[20] http://www.hansgrohe.co.uk/cps/rde/xbcr//uk_en/publications/UK/enUK_HG_EcoSmart_2010.pdf
[21] http://www.hansgrohe.co.uk/cps/rde/xbcr//uk_en/publications/UK/enUK_HG_EcoSmart_2010.pdf

Conventional shower sprays emit the water in many (often more than 20) small continuous jets of water producing a narrow needle-like spray. The water jets are usually set in a circular pattern to balance coverage area and comfort. Newer shower head designs employ different spray types which can result in greater consumer satisfaction and water savings as shown in the examples below.

The Methven Satinjet showers use twin jets of water that collide and turn the water stream into thousands of tiny droplets (see Figure 14). Satinjet showers are also fitted with a flow restrictor, with flow rates of 9 litres per minute and 14 litres per minute. They can also be easily retrofitted.

Figure 14: Satinjet Technology[22]

The manufacturers website indicates that assuming a conventional shower flows at 20 litres per minute on mains pressure, and a household takes an average of four 10-minute showers every day, the Satinjet 9 litre per minute flow model is estimated to save up to 50% of hot water energy costs and 55% on the cost of water. The 14 l/min flow model is estimated to save up to 27% on hot water energy costs and 30% on the cost of the water. The payback period is a matter of a few months. These savings are based on April 2010 Auckland, New Zealand energy and water rates, and are for the water heating portion of the power usage only. Again, the manufacturer indicates relatively short payback times are calculated for potentially significant water and energy savings.

The Nordic Eco shower range is based on a turbine vane-screw design and differs from many other shower designs in that they don't introduce air into the water stream. The water is delivered through the shower handle at full pressure and velocity and is deflected backwards into an expansion chamber from the underside of the screw. This action causes the water to be exposed to periodic and partial under and over pressure. When the pressure reaches a certain level, the water bounces back and out of the chamber about 30 to 40 times per second[23]. This technology manipulates the surface tension of the water droplet to maximise the wetting and rinsing properties.

The Nordic Eco shower delivers a flow rate of either 6 litres per minute or 9 litres per minute, depending on the model chosen. The Galant Max Efficiency model provides 6 litres per minute from 0.8 bar to 5 bar pressures and have an adjustable setting to allow users a wide spray through to a solid stream of water. The Galant Powershower model of 9 litres per minute is reputed to be as effective as a conventional shower with a flow of 19 litres per minute. The shower heads are available at around £50 (approximately 56 Euros).

[22] Image provided by the manufacturer : http://www.methven.com/coming-soon-uk/ and www.satinjet.com
[23] A video is available at http://multishower.org and http://www.nordicecoshower.co.uk/Technical/tabid/767/language/en-US/Default.aspx Further product information is also available here: http://www.nordiceco.com/index.php?option=com_zoo&view=category&layout=category&Itemid=28

The literature for the Nordic Eco showers does not provide an indication of payback; however their website does provide a savings calculator to allow savings to be identified on the basis of individual circumstances[24].

3.1.6 Sensor Taps

Whilst sensor taps can be used for both commercial and domestic applications they are most often used in non domestic premises. Sensors taps are well suited for use within public washrooms since they operate without the user having to touch a button, tap or handle. They are also suitable for use within kitchens, restaurants, schools, hospitals and offices and have been available on the market for a number of years. It is possible that their use could be expanded in the domestic market in the future, depending on the application, however there is no significant indication of this currently.

Automatic sensor taps terminate flow after a fixed duration and generally consist of four key components: a solenoid valve, an infrared sensor, a power source, and a tap unit (see Figure 15).

When the infrared sensor **(2)** detects the presence of the user's hands **(1)** in front of the tap it sends an electronic signal to the solenoid valve **(5)** inside the control box, which initiates the flow of water **(6)**. Water is fed to the user **(8)** via the flexible hose **(7)** connected to the tap. When the object is no longer present, the infrared unit sends an electronic signal to the solenoid valve again to terminate the flow of water usually after a few seconds. The solenoid valve transforms electrical energy into motion, and physically starts and stops the water flow.

'The power consumption of these taps is minimal, for example ≤0.3mW when static and ≤3W when active (at a static current of ≤20μA) , with some models able to operate on four AA batteries, which could last up to two years depending on the level of use[25].

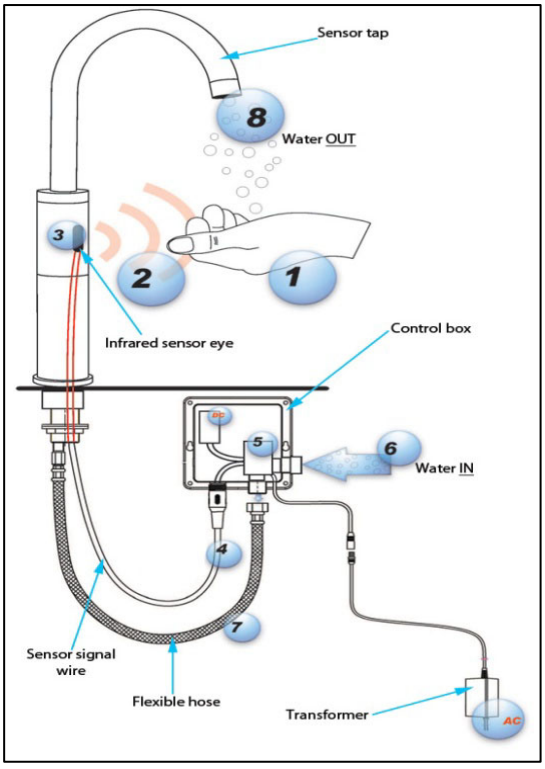

Figure 15: Sensor tap operation [26]

[24] http://www.nordiceco.com/index.php?option=com_content&view=article&id=105&Itemid=30
[25] http://www.autotaps.com/atx-8205-technical-details.html
[26] Personal communication with Autotaps

Sensor taps tend to require less maintenance in terms of parts replacement, cleaning and everyday wear and tear. And because the tap is activated or deactivated within a few seconds they do not drip (a common problem with manual taps). Information collated as part of the Task2/3 report indicates an average price of €375 for an infra red mixer tap.

It is estimated that 15 to 20 percent of new commercial buildings adopt this technology, and save aapproximately 70% water saving per hand wash, use in the kitchen and when brushing teeth. The savings potential for a sensor tap compared to a normal tap is shown in Figure 16. Typically the payback period for sensor taps is 3-6 months[27]

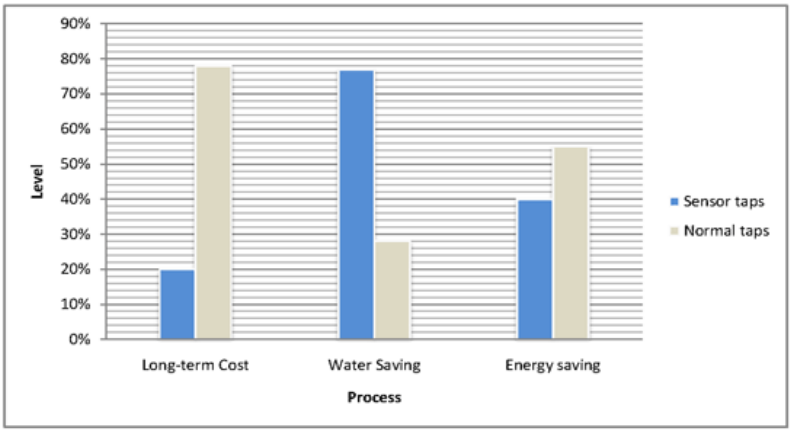

Figure 16: Sensor taps savings potential [28]

The following examples have been provided through the stakeholder consultation exercise. The Dart Valley Systems infra-red electronic sensor tap (see Figure 17) has a flow rate of 6 litres per minute.

Figure 17: Aquarius A32 Infra-red electronic sensor tap[29]

The VOLA HV1E battery operated basin mixer (Figure 18) has an on-off infra-red sensor delay and shut-off of 3-10-20 sec. The shut off times can be set within each product by the user depending on their requirements and is done by setting dip switches in the control mechanism allowing the shut off time to be tailored to specific requirements. The tap is sold with a flow restrictor that limits the flow to 3 litres per minute at 3 bar. The end user can decide whether to use it which may depend on the pressure of the system and end user requirements.

[27] http://www.autotaps.com/benefits-of-electronic-taps.html
[28] Autotaps http://www.autotaps.com/sensor-taps-facts-and-charts.html
[29] http://www.dartvalley.co.uk/shopexd.asp?id=108

Figure 18: HV1E Sensor Tap Basin mixer [30]

3.1.7 Automatic shut-off taps (Push Taps)

As with sensor taps, automatic shut off/push taps are typically used in the commercial sector rather than the domestic sector. Once activated automatic shut-off taps (push action operated taps) give a short flow of water which is terminated after a fixed time interval, typically around 15 - 20 seconds per event. Push taps cannot be left running as they are self closing and are often designed to be tamper-proof and vandal resistant, for example due to their use in public washrooms.

As well as being water efficient, push taps offer a good level of hygiene, and there are designs for hand, elbow or knee operation depending on the end users requirements.

The Dart Valley System Q range models (an example is shown in Figure 19) are supplied with a range of cups designed to give the required flow rate, which can be adjusted between 5 and 9.5 litres per minute. They are also supplied with two discs which are designed to vary the time the taps stays on for between 3 and 11 seconds. The average screw head tap will deliver approx 12 litres per minute when turned partially on.

Push taps are suitable for both high and low pressure conditions, they can have adjustable flow rates, and the manufacturer indicates they can achieve up to 50% water savings[31]. These taps typically cost between €35-€50. Previous research has shown product payback periods of 7 and 3.2 months for cold and hot push taps respectively, based on a slightly lower product price of approximately €26[32].

In order to maximise the potential water saving offered by push taps the use of the tap needs to be considered carefully in order to optimise the settings, in particular the flow rate and running time.

Figure 19: An example of an automatic shut-off tap[33]

[30] http://www.vola.com/Default.aspx?id=169

[31] Dart Valley Systems – Push Tap Product Information Sheet
[32] http://envirowise.wrap.org.uk/media/attachments/236724/GG707R_InfoSheets.pdf
[33] Image provided by Dart Valley Systems

3.2 Summary of Technologies

The key technologies and product information detailed in Section 3.1 are summarised in Table 3.

Table 3: Summary of technolgies for taps and showerheads:

Technology	Flow rate	Water saving potential	Cost saving potential	Price – See Note 1	Product Payback – See Note 2	Barriers to implementation / Limitations
Integrated Aerators/Flow Restrictors	Variable. Typically 2 to 9 l/min at 3 bar	Dependent on end flow rate. Typically 40 - 65% if fitted with a flow regulator		Not provided / unavailable	Paybacks of between 7 and 20 months for the example products, based on a family of four.	Standard aerators do not regulate flow rate on their own, however they are often integrated with flow regulators. Not suitable for use with electrically heated showers.
Flow regulators	Variable; dependent on requirements. Typically 1 - 25 l/min at 3 bar	Dependent on end flow rate required. Typically 40 - 65%		< €5.5 for the flow regulator itself	Zero to a couple of months for the flow regulator itself.	Normally operated in working conditions of up to 45°C, beyond which the performance of the regulator can be slightly affected.
Ecobuttons	Taps: 5 - 7 l/min in water saving position Showers: 8 - 10 l/min in water saving position	Typically 50%		Approximately €25 for the EcoBooster	No payback information available – it will depend on how often the user employs the water saving position compared to the full flow mode.	Not always sold separately to retrofit. Often only incorporated into existing tap or shower ranges.
Taps with water brakes	5 - 7 l/min in water brake position	40 - 50%		Approximately €210 for the example product	Approximately 5 months based on a family of four.	Operation is pressure dependent, generally only suitable for systems with pressure > 1 bar Not suitable for people with arthritis or weak wrists
Water and Energy Saving Tap	Flow rates for the example product not provided / available	Energy Savings of 40 – 50%		Approximately €750 for the example product	Approximately 6.4 years based on a large household.	Higher initial investment
Showerhead Design - Aeration	6 – 14 l/min if fitted with a flow regulator	50 - 70%		Approximately €20 - €120 for the example	Paybacks of between 1 and 6 months for	Aerating shower heads not suitable for

				products depending on supplier	the example products, based on a family of four.	electric showers
Showerhead Design - spray patterns / mechanism	9 or 14 litres per minute depending on product	Estimated to save up to 50% of hot water energy costs and 55% on the cost of water.		Approximately €60 – €220 depending on model purchased	Stated as a 'few months' for the Satinjet example	Lower flow rates can be achieved through other technology e.g. aeration.
Sensor taps	Adjustable flow rates. Typically 3 - 6 l/min	Up to 70%		Task2/3 report indicates an average price of €375 for an infra red mixer tap	Typical payback periods are 3-6 months	Not necessarily suitable for the domestic market
Automatic shut off taps (push taps)	Adjustable flow rates. Typically 5 - 10 l/min	Up to 50%		Approximately €35-€50 for the example range	Product payback periods of 7 and 3.2 months for cold and hot push taps respectively, based on a product price of approximately €26	Not necessarily suitable for the domestic market

Note 1: Prices are provided for specific components or products containing the technology depending on availability of information.
Note 2: Product payback periods are provided based on information from supplied by stakeholders or from the manufacturers product literature/websites. Those included in this table are based on the detailed information presented in Section 3.1.

Additional information on Hot water limiters/barriers

In general hot water limiting features include thermostatic devices included within the design of the product which allow the hot water temperature to be set at a maximum, they are not retrofitted. At a more simplified level it may be a restriction in terms of the mixing of the hot and cold water through limits on the movement of the lever. Hot water limiters are included in particular product ranges at the discretion of manufacturers; however they are a not included across all ranges for a number of different reasons. This may be due to the use of the tap, for example in a kitchen a higher temperature may be required for cleaning, or hygiene. Alternatively in the UK for example hot water limiters are used in the hospital sector, where temperatures need to be limited from a safety perspective as part of best practice.

In addition, hot water temperature can be limited by other means, which can be included within the overall system, but not necessarily as part of the actual tap product. For example on a pillar tap set up a thermostatic valve could be included in the system separately to the tap itself to deliver water at a specified temperature.

In summary, there are different ways to control the temperature at which hot water is delivered and different uses for the water delivered by taps require certain degrees of safety and flexibility to be considered. I would therefore suggest that including requirements for hot water limiters in all taps would not necessarily be appropriate.

4 Conclusions of the Technology Assessment and Implications for Criteria Development

Water efficient taps and showerheads have been manufactured for a number of years in response to the various drivers highlighted in Section 2. The technologies identified are detailed in Section 3, with a summary provided in Table 3.

In many cases, a reduction in water consumption can be achieved by installing relatively cheap and easy to fit flow restrictors, resulting in short paybacks. As noted earlier stakeholders have indicated that this technology has been available for the last decade and is incorporated by the majority of manufacturers across their ranges.

The analysis of the flow regulator technology indicates that they are inexpensive, easily incorporated into products, can be retrofitted, operate across different pressure ranges and can be used to restrict flow volumes across a wide range depending on the products design requirements. Therefore it does not appear that there are significant barriers in achieving lower flow rates for taps and showerheads.

The assessment of the technologies for taps and showerheads indicates that in addition to flow regulators there are an increasing number of other product technologies, or features that are starting to make their way onto the market. These are often included in products in addition to a flow regulator.

The features that are starting to be developed are aimed at controlling or directing the end users behaviour. In the non-domestic sector these types of taps and features have been common for some time, with sensor and push taps often installed, for example in public washrooms. For the domestic sector these products are not necessarily practical, however features such as water brakes and ecobuttons have started to appear in manufacturers domestic product ranges. An important point to consider for products with these types of features is how the products are rated, and the implications this may have for the ecolabel, if not now as part of future revision processes.

Products with features such as water brakes and ecobuttons offer increased flexibility and options to the end user, for example allowing higher flow rates when it is required. However these products would not meet flow rate criteria of say 4 or 6 litres per minute if they are rated on their maximum flow rate. The BMA for example rate products on the maximum flow rate the product can achieve, not the lower default flow rate. At present these features are not that wide spread and this is not necessarily an issue for this set of criteria. However in the future, if the market changes towards these types of products then a form of two stage criteria may be required.

The inclusion of features such as water brakes and ecobuttons does place a premium on products compared for example to the use of a standard flow regulators, although it is often difficult to identify this as other factors such as design, materials and finish will also influence price. However the indication from the information supplied by stakeholders and manufacturers in relation to payback is that over the lifetime of the product cost savings through reduced water and energy consumption mean it is usually more economical to buy products with such features compared to standard products, although this will depend on specific circumstances. In order to maximise the benefits of such features it will be important for consumers to clearly understand how they work and the reason for them.

Feedback from stakeholders correctly highlights that restricting flow rates needs to be considered in the wider context, taking into account other issues, such as scalding risk, different pressure systems and acceptable performance for the end user. These technical issues are discussed in more detail in the Task 4 report however, whatever flow rates can be achieved through technology a balance with these other aspects needs to be reached.

It has already been noted that a minimum flow rate of 4 litres per minute for taps has been suggested by some stakeholders in their feedback and they have also highlighted that there are proposals for the UK Water Technology list to reduce their flow rate criteria to 4 l/min and 8 l/min for taps and showerheads respectively; however it is important to note that these are still only proposals and no decisions to implement the changes have been made. The flow rates set for the ecolabel will need to

be discussed further with stakeholders to ensure they address such issues as minimum and maximum flow rates and whether they should be set at different levels, say for example kitchen taps compared to basin taps.

There are an increasing number of technologies or product features on the market aimed at improving the water efficiency of taps and showerheads in response to the various drivers outlined, including those focused on water use, but also energy consumption and consumer acceptability. Consumers are increasingly aware of the issues, and with a wide range of products available on the market covering a range of performance levels there is an opportunity to differentiate between them on the basis of their environmental performance, and in particular water efficiency aspects. Indeed, manufacturers are already doing this in their own marketing literature as we have seen in this report.

The ecolabel and GPP criteria provide a further means of differentiating between products. The advantages of product labelling and accurate product information regarding payback i.e. life cycle costs, which consumers increasingly understand, and GPP authorities will need to take into account to make informed choices, can be seen by looking at other products as examples, such as compact florescent lamps and condensing boilers. For these products the initial higher investment costs are offset by reduced in use costs and the improved efficiency. Evidence suggests producers and retailers are using payback period (and savings) in marketing material raising consumer exposure to the concept and preparing the ground, we suggest, for a taps and showerhead ecolabel.

When setting the level for ecolabel criteria, for example flow rate, it is necessary to understand the market penetration of technologies and products of a particular standard to ensure criteria are set at an appropriate level, i.e. capturing the top 10-20% for the ecolabel. Unfortunately detailed market data for this product group is limited. However data for the BMA's labelling scheme, summarised in Table 4 provides an indication of the range of products available on the market. Table 5 summarises the existing criteria requirements for relevant ecolabels and labelling schemes.

Table 4: Number of products registered against different flow rates in the BMAs labelling scheme[34]

Flow Rate (litres/min)	Taps (does not include kitchen taps)	Showerheads
1.7	3	
3	3	
3.5	2	
4	21	
4.7	35	
5	67	
6	36	2
8	19	
9	2	5
12	N/A	1

Table 5: Existing ecolabel requirements

Ecolabel Scheme	Criteria
Tourist Accommodation Services	The average water flow of the taps and shower heads, excluding kitchen and bath tub taps, shall not exceed **9 litres/ minute**. An optional criterion is set at 8 **litres/minute.**
Campsite Services	The average water flow of the taps and shower heads excluding bath tub taps, kitchen taps and filling stations shall not exceed **9 litres/minute**. Optional criteria are set at **8 litres/minute.**
Austrian Ecolabel	**6 litres/minute** for sanitary fittings, **9 litres per minute** for kitchen taps and **12 litres per minute** for shower and tub facets
UK Water Technology List	Taps – **6 litres/minute** Showerheads – **9 litres per minute**

[34] Number of products registered as of 7th June 2011 - Data supplied by BMA

The information presented in Table 4 and Table 5 will provide a useful starting point for the discussion at the next ad-hoc working group meeting where the opinions of the wider stakeholder group can be obtained in terms of the level at which flow rates should be set. When compared against the BMA data, it appears that the requirements set by existing ecolabels are readily achievable, and tighter requirements may be required in order to differentiate the top performing products on the market.

At present there are a number of schemes operating at Member State level; however there is a clear role for the European Ecolabel and green public procurement criteria to provide consistent standards and information at the European level to inform consumers and purchasing officers in order for them to make informed choices for taps and showerheads.