BNWAT25: Recycling showers - Innovation Briefing Note

Version 1.0

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis form part of the Evidence Base created by Defra's Market Transformation Programme.

1 Summary

This Innovation Briefing Note considers the potential impact of the introduction of water-recycling showers on the demand for water by 2020. The critical issues that need to be addressed before such showers can be accepted are reviewed and actions to address these issues are suggested.

Greywater re-use, whereby water originating from the mains wholesome water supply that has been used for bathing (showers or baths) and in hand basins is re-used in another appliance such as the WC, is covered separately in BNWAT19[1].

UK domestic demand for water is increasing, and is predicted to continue to rise owing to population growth and changes in society. The proportion of domestic water consumption that is accounted for by showers is also rising. Many households are switching from baths to showers and an increasing number of high-flow showers are being purchased. Recycling showers, although currently rare, offer a potential means of reducing the impact of increased showering upon domestic water consumption. In a recycling shower, water that has been expelled from the showerhead is wholly or partially collected and recirculated through the showerhead, thus reducing the volume of water that is drawn from the mains supply.

There are different types of recycling shower that offer differing flow rates, proportions of water recycled and levels of water treatment. To encourage the growth of this sector of the market, research into both the shower systems and consumer opinion will be required. Public confidence in the health and safety standards of recycling showers will be needed.

The flow rate measured at the showerhead is not an accurate measure of the water consumption of a recycling shower since this will be higher than the actual rate of water drawn from the water supply system. Recycling showers potentially provide a means of meeting consumer demand for higher flow showers while simultaneously reducing the quantity of water consumed.

[1] BNWAT19: *Alternative sources of water – greywater and rainwater reuse: Innovation Briefing Note*.

Assuming market growth from 2015, a 2% share of sales by recycling showers by the year 2020 offers potential water savings of approximately 1.8 Megalitres/day, or 650 Megalitres/year.

2 Sector profile

Domestic showers in the UK account for about 8.0% of household water consumption[2]. Showering is on the increase and it is expected that the contribution of showers to overall domestic water use will also rise. The number of high flow rate showers is likely to increase[3], and these systems will potentially lead to greater water consumption.

Recycling showers have the potential to reduce the magnitude of this increase in water consumption. No company marketing recycling showers in the UK was found during this assessment and only two active companies were found in other countries. Any reduction in domestic water consumption from recycling showers depends upon there being an increase in the profile and availability of these systems.

Quench Solutions Pty Ltd[4] sells recycling showers in Australia. The design of its system is based upon the premise that only a part of the time spent showering is used for cleansing, and the remainder of the time is used for relaxation. Hence the water from the second time period is essentially clean and is recirculated. The company claims to reduce water consumption in the shower by up to 82% for a seven-minute shower. This claim is based on a cleansing time of two minutes and a further five minutes of relaxation showering.

The WoW Shower[5] is an American system which attaches to an existing showerhead and pumps water from the shower tray through a filter and back to the showerhead. A third of the water is replaced with fresh water from the supply system, and it therefore claims to use about a third of the volume of a shower of equivalent flow rate. Both high and low flow systems exist. These were the only two companies found that are currently selling recycling showers.

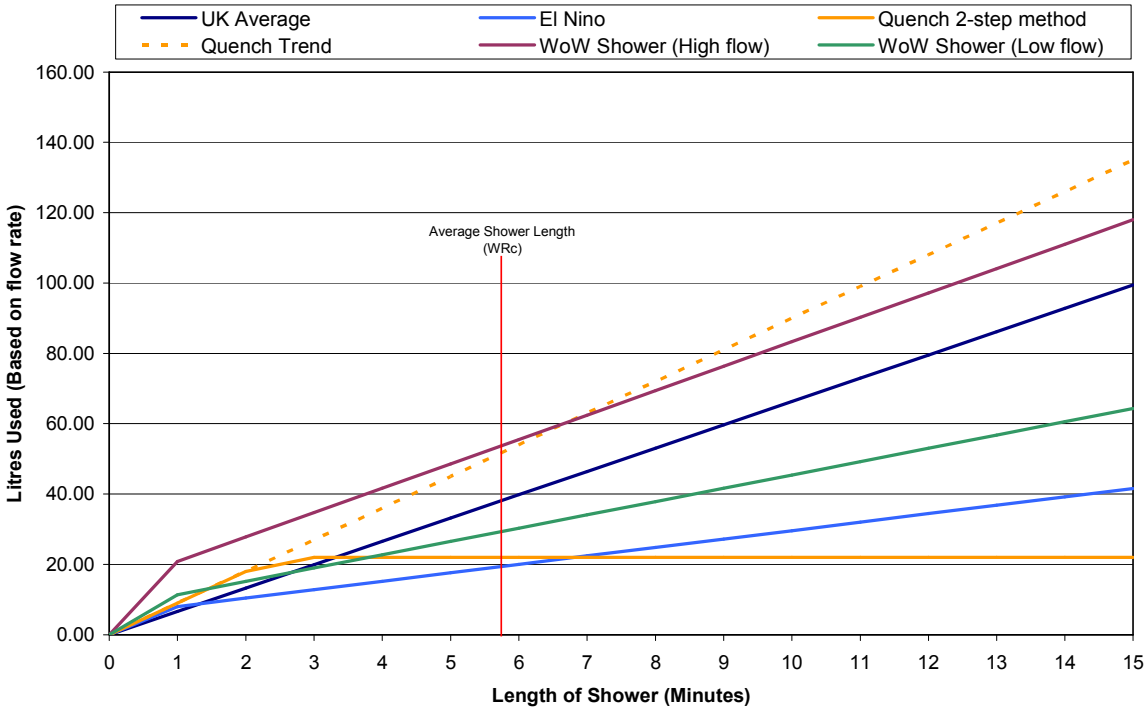
The El Niño System was invented in the UK in 2005 and is in the Royal College of Art's Selected Works portfolio[6], but is yet to appear on the market. The recirculated water is filtered, mixed with 30% fresh water and heated before being returned to the showerhead. It is claimed that this system saves about 24 litres of water and 2 MJ of energy per shower compared to an electric shower. Although the flow rate and shower duration upon which this comparison is based are not stated, compared with

[2] MTP (2006), *Sustainable Products 2006 – Policy Analysis and Projections.*
[3] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[4] www.quenchshowers.com
[5] www.wowshower.com
[6] www.innovation.rca.ac.uk

the flow rate for a 10.0+ kW shower[7] modelled by MTP, it is calculated that this water saving would be achieved for a shower duration of approximately 12 minutes[8].

Figure 1 shows a volume comparison over time for the selected products[9]. The calculations have been based on the assumption that it will take one minute for the recirculated water to return to the showerhead, hence the higher flow rates indicated at the start of the shower cycle for recycling showers. The volume of water used by the Quench system when not in recycling mode is also shown (Quench Trend), as this is an option on this appliance.

Figure 1 Water consumption by recycling showers[10]



There are also several patents held in the UK and abroad for recycling shower technologies. The Boeing Company installed recycling shower systems into a small number of its business jets but the high cost of these systems made them uneconomic for commercial airplanes or domestic usage. The US Army has also undertaken experiments into recycling showers but to date has not utilised the technology on a large scale.

[7] 10.0+ kW flow rate from BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[8] Note, the 10.0+ kW shower flow rate is lower than the UK average, and hence not indicated in Figure 1.
[9] Flow rates and water efficiencies taken from company and inventor information.
[10] Average shower length taken from MTP modelling work reported in BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*

3 Technology drivers

3.1 Energy reduction

Water use and energy consumption are inextricably linked so that energy is consumed whenever water is used[11].

There are three primary areas of energy use related to water:

- Energy embodied in the water supplied and wastewater treated.
- Energy used to heat domestic hot water and for central heating.
- Energy used in appliances (eg dishwashers and washing machines).

The above are sometimes referred to as the 'carbon content or carbon footprint of water'.

3.1.1 Embodied energy

Pumping operations to move the water from the point of abstraction, through its various treatment stages and to the consumer require a significant amount of energy. This energy, known as the embodied energy of water, will be the same for each unit of water used regardless of the total volume used. However, if the recycling shower uses a lower total volume of water, then the total amount of embodied energy associated with the showering event will be lower.

3.1.2 Heating domestic hot water

The hot water used during showering can be heated either by a central boiler or by the shower unit. Since the hot water consumption is via the shower, the energy consumption for heating the volume of water required for showering can be attributed to the appliance, regardless of which method of heating is used by different shower systems.

3.1.3 Energy used in appliances

Recycling showers re-use heated water, meaning that potentially less energy is needed to reheat the recycled water to the required temperature for the shower. Overall, therefore, the energy required to heat the water for recycling showers should be less than for an equivalent volume conventional shower.

Some conventional showers use energy for pumping water, whereas all recycling showers consume energy to pump the recycled water from the shower tray to the showerhead. They may also consume energy during the treatment of the recycled water.

[11] For further information see BNWAT18: *Accounting for the trade-off between energy and water use - Innovation Briefing Note.*

3.2 Waste minimisation

The water used in showers is normally of drinking water quality standard and is supplied via the water distribution system. Any water treated to this high standard which is not required for essential purposes (drinking, cooking, basic hygiene) can be termed as 'wasted' water. Recycling showers could use a lower volume of high-quality water than an equivalent standard shower for the same duration of shower, and would thereby reduce the wastage of high-quality treated water.

Wastewater from showers necessarily undergoes energy-consuming treatment before it is discharged into the environment. Recycling showers will produce less wastewater and so reduce the amount of energy consumed by treatment. However, certain recycling showers treat the recirculated water before pumping through the showerhead and this process uses additional energy. It is also possible that increased concentrations of organic matter within the wastewater mean that the energy required for treatment will overall remain relatively stable.

3.3 Water utilisation

There are two general types of recycling shower:

- The first type merely filters, reheats and recirculates the shower water without a treatment process to remove shampoos and soaps. This type is designed to reduce the volume of water which is frequently used for relaxation purposes after cleansing has occurred. During the cleansing process the water goes to waste in the same way as for a normal shower. After this stage the water is recycled. A quick cleansing process is recommended to reduce the time during which the water is not recycled. The Quench shower system is an example of this type of recycling shower.

- The second type treats the recycled shower water to remove soaps and impurities before it is pumped back to, and recirculated through, the showerhead. The recycling process with this type can be used for cleansing as well as relaxation purposes. Typically, this type of shower draws some water from the distribution system to mix with the recycled water in the treatment process[12]. In these showers the water is either reheated or mixed with hot water from the plumbing system to achieve the desired temperature. The El Niňo system is an example of this type of recycling shower.

Both types are more efficient, in terms of water utilisation, than non-recycling showers of equivalent flow rate, as less water is drawn from the external distribution system for the same shower duration. The first type requires only enough water to wash with and to fill the shower tray and then requires no more water to be drawn from the supply system. The second type requires water to be continually drawn from the distribution system but the high proportion of recycled water means that the quantity of 'fresh water' is greatly reduced.

[12] It is important that if this type of shower were to be installed in UK homes that backflow prevention was ensured, and compliance with WRAS guaranteed.

Currently, showers can be included on the Water Technology List if they have a maximum flow rate of 9 l/min or less at dynamic pressures of up to 5 bar[13]. This measure is not an accurate indicator of efficiency for recycling showers as the flow rate from the showerhead does not reflect the actual volume of water consumed by the shower. A more relevant measure would be needed for recycling showers. The flow rate measured at the showerhead could be termed the 'effective flow rate' that the user experiences; the flow rate drawn from the water supply could be termed the 'consumed flow rate'. The consumed flow rate is the key measurement in terms of water efficiency for recycling showers.

It is important to remember that the amount of water used by a shower will depend largely on user behaviour.

3.4 Changes in society

The growth of additional bathroom facilities in existing homes will continue to support growth in the shower market. This increase is expected to be 2.5% per annum from 2007 to 2012 and then 1% per annum after this[14]. The increase in the number of showers in the UK will be matched by an increase in the water consumption by showers. This change is likely to be driven by several factors:

- The replacement of baths with shower enclosures is increasing, especially in smaller homes where space is more restricted and en-suite bathrooms are less common[15].
- The growth of the new-build sector, with an estimated 4 million homes required over the next 20 years[16]. The Government has announced plans for 3 million new homes to be built by 2020[17]. An increasing number of new-build homes are being built with more than one en-suite bathroom, with a shower in each one.
- A greater acceptance of showering amongst the population generally.
- A shifting age mix in the population, with older people less likely to shower but a larger proportion of younger people in the population showering more often[18]. It is also possible that an ageing population may increase the number of walk-in showers utilised by people who find them easier to access than baths. Overall, it is likely that there will be an increase in the total number of showers taken.
- An increase in the frequency of showering related to a rise in 'recreational' showering for relaxation purposes. Frequency of use is expected to increase from an average of 0.49 to 0.66 showers per person per day[19].

[13] www.eca-water.gov.uk
[14] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[15] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[16] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[17] Prime Minister's speech to House of Commons (11/07/07) on draft legislative programme, www.direct.gov.uk
[18] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*
[19] MTP (2006), *Sustainable Products 2006 – Policy Analysis and Projections.*

An increase in the proportion of recycling showers in this market would reduce the magnitude of the increase in water consumption.

4 Goals

- To increase the market penetration of recycling shower systems to 2% of sales by 2020 and thus reduce water consumption[20].
- To ensure recycling showers are developed that are compatible with the existing plumbing and drainage systems, compliant with water regulations and are acceptable to users in terms of style, design, ease of use and ease of maintenance.
- To develop standards and test methodologies for recycling showers to promote confidence with respect to their safety and hygiene levels.
- To encourage clear product information for recycling showers that explains the water savings, energy savings and hygiene standards achieved.

5 Effect on MTP scenarios

The impact that achieving the goals contained in this Innovation Briefing Note would have on the Earliest Best Practice (EBP) scenario within the MTP projections has been investigated.

The scenario is based upon the reported volumes and flow rates of the Quench and El Niño shower systems, which are assumed to be representative of the two different types of recycling shower. It has been assumed for modelling purposes that recycling shower sales in the future will be split equally between the two types.

Type 1 recycling showers, such as the Quench shower system, were incorporated into the model for mixer showers with an integrated pump. This is because the Quench shower system most closely fits into this category: being fed hot water from a boiler and having an integrated pump. This shower system requires both hot and cold water to be plumbed in.

Type 2 recycling showers, such as the El Niño recycling shower, were integrated into the 10.0+ kW electric shower model on the basis that the delivered flow rate from this type of electric shower and the El Niño recycling shower are similar. Also, both shower types heat the water at point of use and require only a cold water feed. The recycling shower will actually give a higher effective flow rate for a lower (6 kW) electrical rating because less energy is required to heat the recirculated water. Therefore, less energy is used by the recycling shower than by a non-recycling shower with an equivalent flow rate.

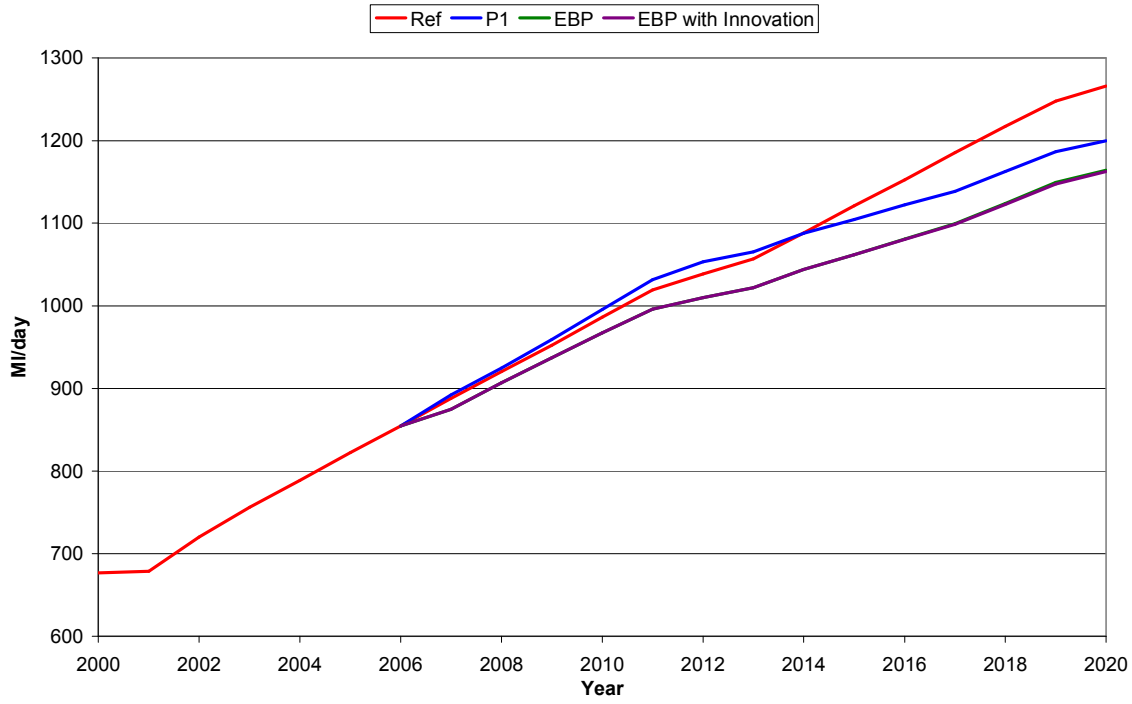
It is assumed that by 2015 recycling showers will be available to consumers and the uptake of these will increase until they account for 2% of shower sales by 2020.

[20] A market penetration of 2% is highly ambitious, but has been chosen to reflect the best possible scenario of water savings which could be attributable to recycling showers.

In 2020, the potential reduction in water consumption by recycling showers is approximately 1.8 Megalitres/day over the existing EBP scenario line[21]. This saving would be achieved despite recycling showers providing a higher rate of flow from the showerhead than the showers they replace. The recent growth in the sales of more powerful showers suggests that a higher effective flow rate is desired by consumers, and recycling showers can provide this while consuming lower volumes of water than a shower with a low effective flow rate[22].

Figure 2 shows the impact of achieving the goals on the EBP scenario for showers.

Figure 2 Impact of recycling showers on MTP scenarios



Since the scenario assumes that market growth would only be seen from 2015, the impact by 2020 is small. If the scenario were to be extended beyond 2020, the impact of recycling showers on total water consumption by showers would be expected to increase and larger savings to be seen.

6 Critical issues

6.1 Health and hygiene

Reliable information is required on the potential public health and hygiene impacts of introducing recycling showers on a large scale. Standards are required for the quality of the water delivered by these systems. The filtering and treatment processes of any existing or new systems must be effective and safe, and must be perceived to be

[21] Owing to the scale of total water consumption by showers, this difference is not clearly visible in Figure 2.
[22] BN DW Shower: *Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief.*

safe if the public is to have confidence in the product. Recycling showers which do not treat the water must be clearly labelled so that consumers are aware of the need to wash themselves before recirculating the water. The maintenance procedures, such as replacement of filters, need to be fully understood by the user to ensure consistent hygiene standards. This need for regular intervention could act as a barrier to uptake.

6.2 Product development

There are no recycling shower systems currently available in the UK. Further investigation is required to determine the reasons and to enable appropriate solutions to be implemented.

Potentially, it may be possible to order and install units from the USA or Australia provided that these units meet the requirements of the Water Regulations Advisory Scheme[23] (WRAS).

6.3 Affordability

Price comparisons for recycling showers in the UK based on actual data are not possible as there are currently none on the market. Also, there are little data from elsewhere owing to the very small number of systems sold worldwide.

The installation cost will have a bearing on the full cost of the unit and will vary depending upon factors other than the price of the unit, such as ease of installation. It is assumed that a recycling shower will cost more than a non-recycling shower of equivalent performance. The assumed higher cost of a recycling shower over a conventional shower could be offset by the savings in water (for metered customers) and energy costs associated with the reduced volume of water consumed. The period of time taken for the savings achieved to match the initial extra cost is referred to as the 'payback period'. As the duration of the payback period increases, the shower becomes less economically appealing to the consumer. In general, users with a metered water supply, and who have a higher showering frequency or longer shower duration, will have a shorter payback period. These will include mass users, such as hotels and leisure centres, for which recycling showers may offer an effective way of reducing costs.

6.4 Consumer awareness

Currently, the majority of consumers are unaware of recycling showers but this is probably due to the non-availability of products. Raising public awareness of water resource issues and the energy needed to provide and heat water may increase the demand for recycling showers, but this will need to be in tandem with product availability.

6.5 User acceptability issues

There are no data available regarding consumer acceptability of recycling showers. It is likely that this will be a major hurdle that will have to be overcome if these units are

[23] www.wras.co.uk

to take a significant proportion of the shower market. This may require consumer perception, which is not solely based upon safety or hygiene considerations, to be changed.

6.6 Energy/water balance

The recycling shower systems currently available claim to save energy because of the reduced amount of energy needed to reheat the already warm, recycled water. Smaller volumes of wastewater from recycling showers will use less embodied energy in treatment and pumping by water suppliers but the shower's internal pump and treatment process will consume energy. Therefore, the total energy balance must be determined to assess whether recycling showers will increase or reduce overall energy consumption. Any increase in energy consumption should be carefully assessed against the resultant water savings.

6.7 Shower experience

The effect, if any, of recycling showers on the showering experience, and thus on consumer satisfaction, is important. Recycling showers must be able to produce an acceptable flow rate when fed by fresh water from gravity flow pipes.

6.8 Drainage research

The potential impact of recycling showers in conjunction with other water-saving measures, such as the introduction of lower flush WCs and the increasing switch from baths to showers, on the performance and operation of the existing drainage and sewerage system is not understood. There may be a risk that the decreased volume of wastewater will lead to an increase in the blockage rates of drains and sewers, particularly for those drains and sewers that have intermittent flows.

7 Actions

7.1 Health and hygiene

Set standards for the water quality delivered by recycling shower systems. Display these standards upon the systems so that consumers can have confidence in the product.

7.2 Product development

Consumer research is needed to evaluate the potential acceptability of recycling showers to encourage manufacturer development and take-up.

7.3 Affordability

Investigate the 'payback period' for installation of recycling showers under different scenarios.

7.4 Energy/water balance

Investigate further the energy and water demands of recycling showers in relation to current shower systems. The trade-off between decreased water consumption and lower energy demand for heating water but increased energy usage for pumping, filtering and treating water needs to be fully considered.

Investigation into the benefits of recycling showers versus other recycling techniques such as greywater re-use should also be considered, as these alternatives could offer increased benefit.

7.5 User acceptability

Gather evidence to gauge public opinions and reactions to recycling showers.

7.6 Drainage research

Gather evidence to determine whether the use of recycling showers will have any detrimental effects on the operation and performance of existing drainage and sewerage systems.

Related MTP information

Briefing Note BNWAT18: Accounting for the trade-off between energy and water use - Innovation Briefing Note

Briefing Note BNWAT19: Alternative sources of water – greywater and rainwater reuse: Innovation Briefing Note

Briefing Note BNXS25: UK household and population figures 1970-2020

Briefing Note BN DW Shower: Actions to improve shower design and efficiency – Briefing Note relating to policy scenario objectives in Policy Brief

Briefing Note BNWAT06: Showers - water efficiency performance tests

Briefing Note BNWATSH01: Consumer views about showers - summary report

Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email **info@mtprog.com** quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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