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

Version 1.3

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

Water use and energy use are inextricably linked. It may appear on first examination that, in most instances, water is energy-free - water appears when a tap is turned on and stops when the tap is turned off. It is also comparatively easy to discern the few instances where energy is directly linked to water use, such as hot baths and warm showers. In fact, energy is used at all stages of water use by a consumer. This immediately suggests that reducing water use may also reduce energy use.

2 Primary areas of water and energy use

There are three primary areas of water and energy use. These are:

- The embodied energy use in providing water to homes. This is primarily for pumping the water. Anecdotal evidence suggests that up to 70% of the energy use of a water company is for pumping. There is also an embodied energy use in waste water, again primarily pumping, to push the water through its treatment process. This energy use applies to both domestic and commercial/industrial water use.
- Domestic hot water (DHW) and central heating. These are the greatest energy users in the domestic arena.
- Water-using appliance energy use. Dishwashers and washing machines use both water and energy to perform their tasks, and are energy labelled. The new condensing tumble dryers, which use water to condense water vapour released when heated air is blown through clothes, are also energy-labelled appliances.

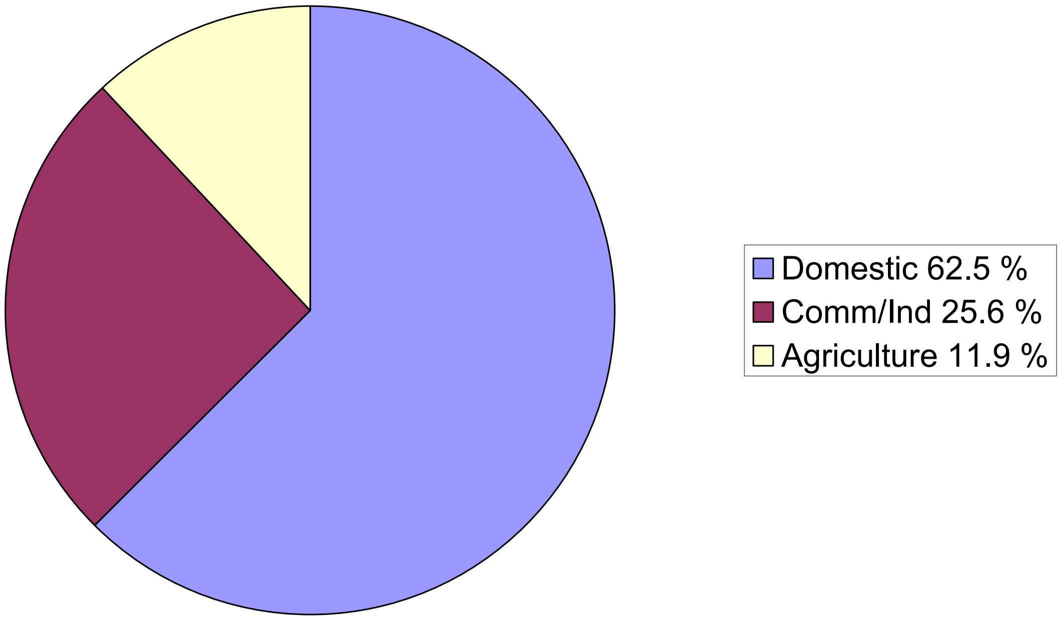
These three areas represent the greatest energy use related to water. There are some minor areas which may become significant in the future, for example the use of water softeners in homes and the large-scale use of desalination plants. There are also some appliances, such as recycling showers and condensing tumble dryers, that have not yet penetrated the market to any great extent.

Reducing water use in general will automatically reduce the embodied energy used. However, it is not necessarily the case that reducing water consumption will reduce the specific energy use of a water-using appliance.

3 Sector profile

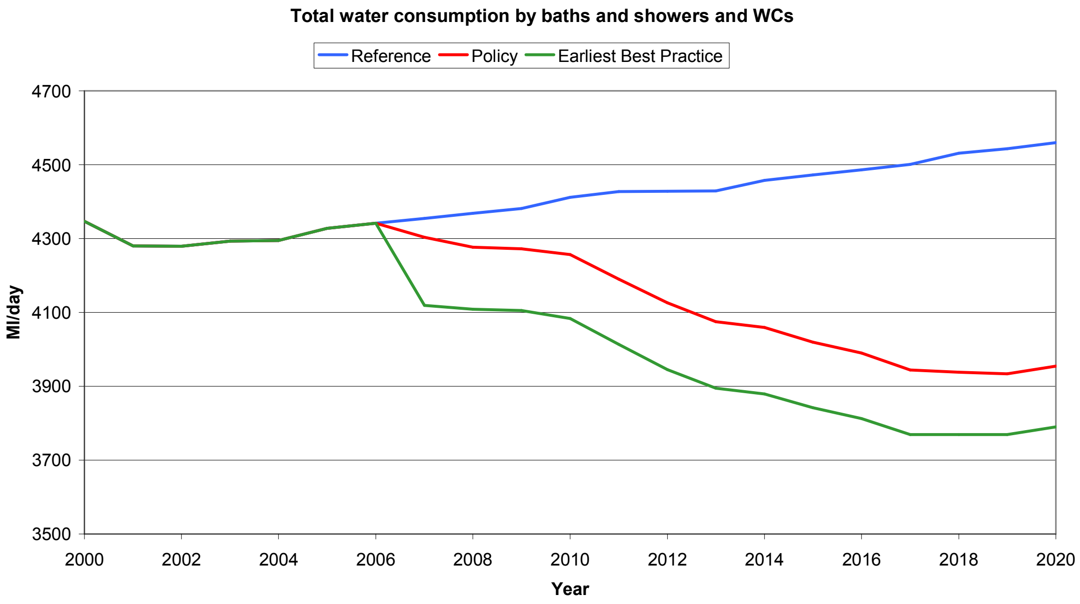
Total water use in the UK is 6.26 x 106 Ml/yr. Figure 1 shows the split between domestic, industrial and agricultural water uses.

Figure 1 Water use split – domestic, commercial and industrial, and agricultural



Total water consumption (without implemented solutions) is expected to increase over the period 2005 to 2025. Figure 2 shows the expected growth in water consumption and the possible effects of implementing water efficiency measures.

Figure 2 Water consumption increase and the possible effect of implementing P1 and EBP water efficiency measures



P1 (Policy – proposed actions) estimates the outcome, in terms of water consumption by end-users, of an ambitious but feasible programme of critically timed policy measures and other logistical actions, judged to be both necessary and sufficient to deliver the specified market transformations. For example, with baths, P1 actions reinforce the extant trend of shift from bath use to shower use and, thereby, deliver the projected water outcome.

EBP (Earliest Best Practice) sets a boundary condition for the most ambitious practical rate of market transformation and shows what could happen if, in any year, the market was to take up the most cost-effective, identified (Best Practice) options, taking into account the likely timing and introduction to the market of specific innovations and technologies. For the above example, EBP actions accelerate the trend towards shower use.

Figure 2 shows the expected result of both P1 and EBP measures compared to the reference case of increasing water consumption.

4 Technology drivers

Energy efficiency measures are implemented in many energy using situations as a matter of course and, in some cases, legislation has been passed to require energy consumption to be minimised.

4.1 Embodied energy consumption

Pumping operations to move water through its various treatments and to point-of-use are probably already relatively highly efficient operations. To improve energy consumption, two requirements would be necessary:

- A reduction in demand, requiring less water to be pumped.
- Technological improvements to either the pumps or motor drives, so reducing energy consumption. This area is probably better treated as a subject for a further roadmap looking at energy and water conservation through technological enhancement.

It is estimated that 70% of a water company's energy is used to pump water. This represents, for the UK, an energy usage in the order of 3.7 TWh/yr, corresponding to 4.36 x 10^6 Ml/yr.

4.2 Domestic hot water and central heating energy consumption

Domestic central heating and DHW energy use is of the order 410 TWh/yr. Heating and hot water are considered together as it is normal practice to have a composite system, with one boiler providing both services.

- For the housing stock as a whole (average SAP = 42), heating and hot water accounts for 83% of the energy consumed (61% for heating; 22% for hot water). This is equivalent to about 24% of all UK energy consumption.
- In newly built houses with a good standard of insulation (SAP = 80), the heating requirement is reduced by about 75%, but the hot water energy requirement is much the same. Nevertheless, even in newly built houses where the SAP = 80, heating and hot water still accounts for 72% of the energy consumed.

Implementing a number of energy saving measures is expected to reduce usage by between 11% (P1) to 12% (EBP) by 2010.

4.3 Water-using appliances

Most water-using appliances are transfer or holding/storage devices which pass or hold water with no other inputs. For example, non-electrical showers and taps are transfer devices, whereas baths and sinks hold water for use. These appliances use DHW but do not provide the heat. Electrical showers, whether of standard type or the newer steam and recycling types do, however, have an energy input.

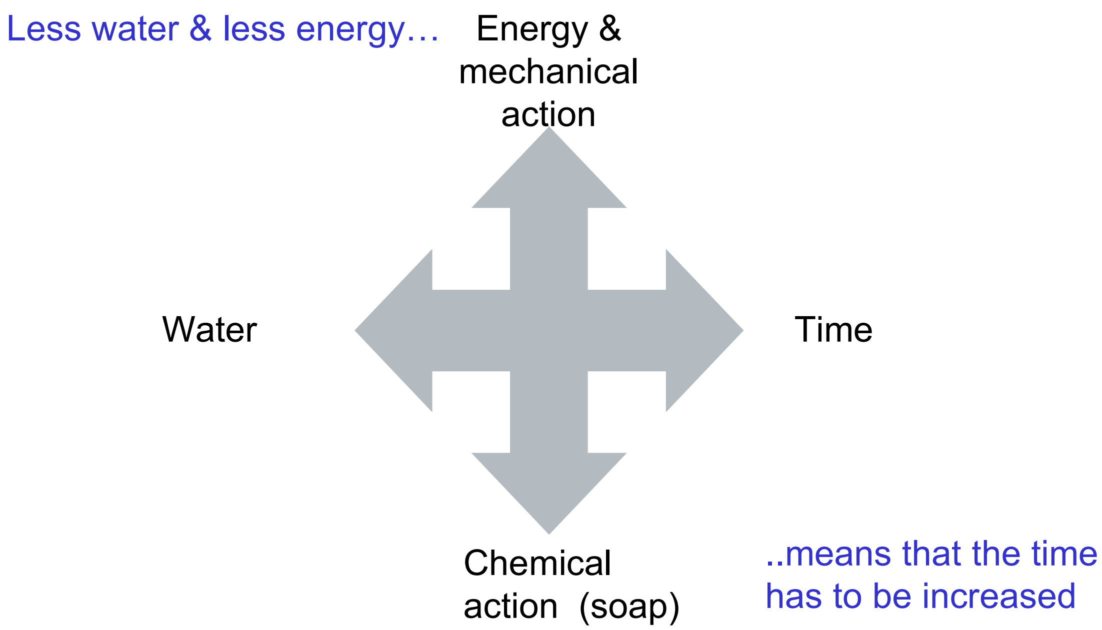
Appliances such as washing machines and dishwashers use energy as well as water as part of their operation. These appliances are required to be labelled for energy, but there is no requirement for water labelling. The energy label does have a water consumption value on it but this does not indicate whether the appliance is water efficient or not. There are plans to develop a water labelling scheme. At present this is intended to be voluntary, and a pilot scheme will be undertaken in the near future.

Water may be used to improve the energy rating of an appliance. This really only occurs in a new type of tumble dryer which uses water running through a coil to condense out water from clothing. These dryers achieve an energy rating of B compared to other conventional dryers that achieve an energy rating of C. The water use and efficiency aspects of these new tumble dryers is being examined as part of the white goods wet sector of the MTP programme.

Testing methodologies to establish the water efficiency of appliances have been developed and are to be found in Briefing Notes on the MTP website.

It must be borne in mind that there is a conflict between the various driving factors. The following figure shows this:

Figure 3 The relation between factors for some water using appliances

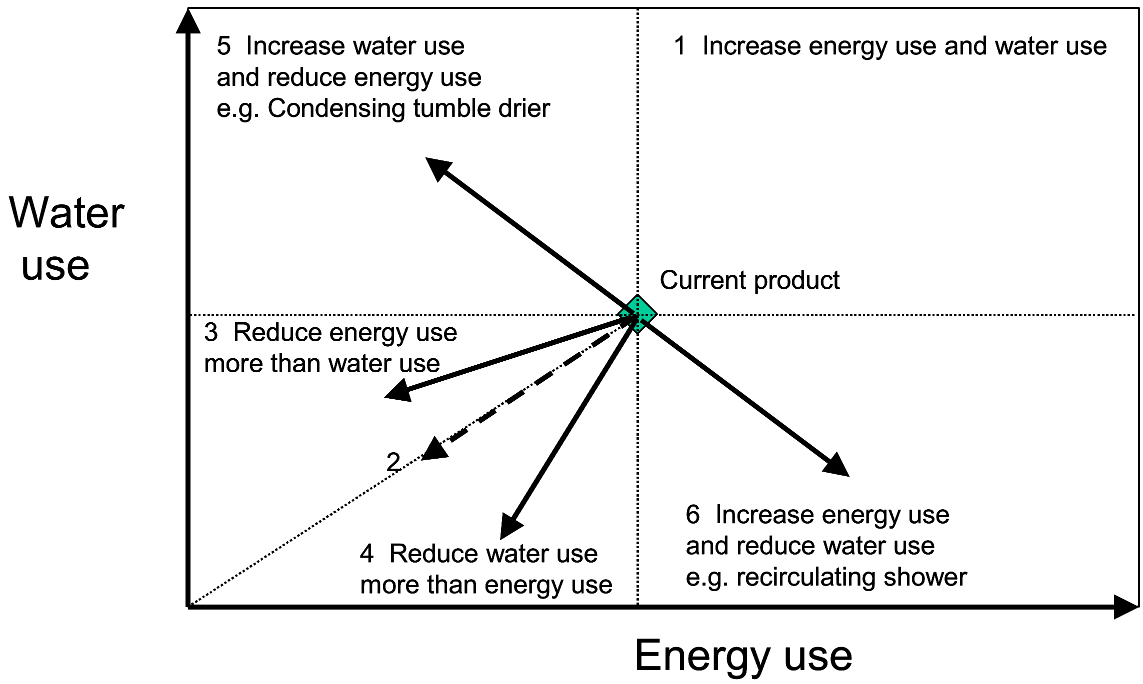


The above diagram shows the interrelationship between the factors defining the operation of an appliance, such as a dishwasher or washing machine. If you wish to reduce water consumption then some other factor must change to accommodate this.

For example, over the past few years the water consumption of washing machines has been reduced significantly. However, this has resulted in an increase in the length of a wash cycle.

The relationship between the energy and water use of a product can be illustrated as in Figure 4 below. Development may position the product in different sectors of the relationship using less energy or water compared with the current products.

Figure 4 General relationships between water and energy use.



The figure illustrates ways in which at least one resource may be reduced in products that use both energy and water.

2. Energy use and water use reduce equally
3. Energy and water use both reduced, with the reduction in energy use proportionately greater than that of water.
4. Energy and water use are both reduced, with the reduction in water use proportionately greater than that of energy.
5. Energy use is reduced and water use is increased.
6. Water use is reduced and energy use is increased.

Where the use of one resource is decreased, but the other is increased, it is not necessarily clear which is the most sustainable product (eg regimes 5 and 6). Even where both water and energy are decreased, several different combinations may be possible, leading again to questions as to which is the most sustainable improvement (eg comparison of regimes 2, 3 and 4). This does not become an issue for products where water and energy use are both reduced. In all other cases, an understanding of the trade-off between energy and water use is required both to compare products, and to direct the development of more sustainable products.

5 Goals

To enable realistic assessments of P1 and EBP scenarios it is necessary to develop evidence of the energy use associated with water use in relevant products. The following three actions must be carried out so that realistic estimates can be made:

- **By collaborating with the water companies, evaluate the embodied energy use of both water provided to the home and waste water treatment.**

The Watermark Project involved a comprehensive study of the effects of energy use and CO_2 emissions within the water industry. The project found that the national average energy use in 1998/99 for the supply of water and the treatment of wastewater were:

- 468 kWh per megalitre of water supplied;
- 437 kWh per megalitre of wastewater treated.

It is recognised that these figures are now more than five years out of date, and that more uptodate research is required.

- **Determine how much energy DHW and central heating systems use and how effective energy saving measures are.**
  The domestic heating area of MTP covers this subject. Relevant briefing notes include 'BNDH06 Ranking of Energy Saving Measures in the Home' and 'BNDH17 Water Heaters – Proposed Energy Labelling Directives'.
- **Investigate the balance between energy use and water consumption for white goods (washing machines and dishwashers).**
  The domestic wet products area covers this subject. BNW05 states 'Water and electiricity consumption are closely related because of the energy use for heating the water (80% of the energy used is for heating the water in the wash phase)'.

6 Effect on MTP scenarios

Reducing water use by implementing effective water efficiency measures will have the knock-on effect of reducing energy use:

- Less water use requires less energy for pumping.
- There will be less waste water to treat.
- More efficient DHW and heating systems will use less energy and, if water efficient appliances are used, less water.
- By optimising the relationship between energy and water use and the other factors shown in Figure 4, both water and energy use will be reduced.

Reducing embodied energy by implementing water efficiency measures will save 520 GWhr/yr (1.25 x 106 Ml/yr) if P1 savings are achieved, and 1.05 TWh/yr (2.5 x 106 Ml/yr) if EBP savings are achieved.

There is less scope to reduce water usage for DHW or central heating.

The connection between water and energy use for white goods is a complex issue and requires further work to evaluate potential savings strategies.

At present energy is the primary conservation concern because of increasing costs and changes in energy supply sources. However, water is increasing in importance as large areas of the UK become progressively more water stressed. In the long term, the financial and environmental benefit will be both energy and water-related as both resources equalise in importance. Reconciling the energy/water trade-off will result in energy and water use being optimised in those circumstances where the two are inextricably linked. In fact, it may be that water becomes more important than energy in the long term as increased renewable energy exploitation and low carbon energy generation becomes more significant.

7 Enablers and key actions

- Embodied energy use needs to be defined as part of a general water and energy conservation effort. The water companies will be instrumental in doing this as they have the greatest incentive to reduce their use of both resources.
- DHW/central heating energy use needs to be defined. The most efficient scenarios need to be developed as part of forward planning and regulation revision requirements.
- The water/energy use of appliances such as washing machines and dishwashers needs to be defined and optimal combinations established.
- Establish contacts with the water companies and start to develop a database of energy usage.
- Continue to support the DHW evaluation work of the MTP in developing a database of related water and energy uses.
- Establish contacts with wet sector white goods manufacturers to develop methods of testing such goods in order to determine and optimise performance.

Related MTP information

BNDH06 Ranking of Energy Saving Measures in the Home

BNDH17 Water Heaters - Proposed Energy Labelling Directives

BNW05 Assumptions underlying the energy and water projections for washing machines

Changes from version 1.2

Figure 2 has been updated to reflect current MTP modelling.

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.

For further information on related issues visit **www.mtprog.com**