IBNW23: Innovation briefing note on domestic laundry washing products and services

Version 1.2

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

Executive Summary

Domestic laundry accounts for a significant proportion of the electricity and water consumption in the UK. If government targets on reducing carbon dioxide emissions are to be met, substantial reductions in energy consumption for laundry will be needed (unless there are large changes in the way electricity is generated).

This paper considers the options for reducing the amount of electricity and water used for laundry. These are:

- improvements in washing machine design
- improvements in detergent dosing
- choice of textiles
- use of commercial laundries

The design of washing machines has improved substantially over the last ten years with respect to electricity and water consumption. Much of this change has been brought about by the EU energy label scheme and the Energy Saving Trust's Energy Saving Recommended (ESR) scheme,[1] which promote the more efficient products at the point of sale. However, consumer habits and lifestyles are changing. Consumers on average live in smaller homes with fewer people, they have larger washing machines, do not fill them to capacity and commonly wash using lower temperature programmes. If they are to continue to drive improvements in the efficiency of laundry appliances, these schemes will need to be modified to take account of recent changes in consumer habits and lifestyle. A revised energy label would help drive further advances in washing technology such as ensuring that energy and water consumption are reduced automatically to match the size of the load being washed. A more challenging energy label will also encourage other more radical designs.

The manufacture and distribution of detergents constitutes a significant component of the total energy consumed by domestic laundry. Voluntary agreements with the

[1] www.est.org.uk

detergent manufacturers[2] have achieved a significant reduction in the quantity of detergent used and in the energy required to produce it. Accurate dosing remains an issue and there is a potential for savings if an effective demand based automatic dosing system could be developed for washing machines.

Textile type affects the energy requirement for laundry because it dictates the maximum temperature of the wash. In addition, textiles are available with

- water repellent properties that reduce drying costs
- stain repellent or self-cleaning properties that reduce the frequency of washing and the use of detergent.
- anti-crease properties that reduce the need for ironing.

Promotion of these textiles into mainstream clothing and bedding could lead to significant savings in energy and water consumption.

Commercial laundries are currently only used by a very small minority of households. Economies of scale suggest that commercial laundries could be more efficient than home laundry especially for homes with only one or two occupiers. This would be conditional on efficient delivery and collection systems being available and the cost and convenience of the service being acceptable to consumers.

In addition to technical and organisational improvements there are significant energy savings to be made if consumers were to be educated in the efficient and effective use of their washing machines. Ensuring that the washing machine is loaded to capacity and selecting the coolest appropriate programme are two aspects that could potentially yield significant short-term savings in water and energy.

A conservative estimate of the savings associated with the proposals outlined in this paper suggests that a large proportion of the government energy target for 2050 could be achieved by 2020.

[2] www.aise-net.org

1 Sector Profile

1.1 Introduction

Domestic washing machines in the UK are currently consuming an estimated 4.8 TWh electricity annually. Energy saving policies to date are expected to reduce electricity consumption to 4.75 TWh per year by 2010. Despite the increase in homes expected by 2020, overall energy consumption is only expected to remain virtually static at 4.80 TWh as the existing energy policies take effect[3].

Government is aiming to reduce carbon dioxide (CO_2) emissions to 40% of the 1990 levels by 2050 and to make significant progress towards this target by 2020. Based on the 1990 annual energy consumption figures for washing machines of 5.4TWh[4], the 2050 target is 2.0TWh assuming the bulk of this energy is still generated by fossil fuels and translates into CO_2. On this basis, further reductions in washing machine energy consumption need to be achieved over the coming years unless substantial changes are made to the way electricity is generated in that time.

This paper explores the technological and lifestyle changes that could be made to bring about the required reductions. The scope of this paper excludes laundry drying, which is covered in a similar document entitled Innovation briefing note on domestic laundry drying products. Washer dryers are also excluded, although many of the principles discussed are equally relevant to these appliances.

[3] Briefing Note BNW05: Assumptions underlying the energy projections for domestic washing machines.
[4] MTP What if tool: http://www.mtprog.com/WhatIf.aspx

1.2 Washing machine energy label

Significant energy efficiency improvements in washing machines have been developed as a result of the energy label scheme. There have been similar improvements in water consumption over the same period – average water consumption having decreased by one third[5]. However, with washing machines having a lifespan of approximately 12 years, there is consequently a large stock of less efficient washing machines still in use.

The energy efficiency improvements achieved with washing machines so far have been focused on the 60°C cotton programme with a full load. But the trend in the home has been for more use of the 40°C and other low temperature programmes and only to partially fill the washing machine. Substituting the 60°C programme with the 40°C programme can reduce energy consumption by approximately 40 %, but under-loading the washing machine results in reduced energy and water efficiency because most washing machines do not automatically reduce energy and water consumption in proportion to the reduction in load size.

Some washing machine manufacturers have incorporated features that claim to adjust energy and water consumption to match the requirements of small loads. Generally these only provide limited savings though. The potential exists for much greater savings[6] and the energy label could be used to promote this.

Confusingly, some washing machine manufacturers have achieved A class energy consumption by reducing the maximum wash temperature of the 60°C programme to little more than 40°C. In these cases there is no significant energy saving made by moving from the 60°C programme to the 40°C programme. The consumer also loses out when the 60°C programme fails to reach the declared wash temperature and thereby fails to achieve the desired hygiene conditions. The energy label does not set a requirement for wash temperature.

[5] Stamminger, R. CECED washing machine workshop. Brussels 2005.
[6] Rudenauer, I; Gensch, C; & Quack, D: Eco-Efficiency analysis of washing machines, 2005.

1.3 Technology

In the UK the basic design of the washing machine has remained unchanged in the UK since the introduction of horizontal axis machines in the late 1960s. There has been a move in recent years towards larger drums with greater load capacity. When fully loaded, these can be as efficient and effective as smaller washing machines. However, consumers do not fully load their washing machines in practice, which means that the washing machines do not deliver the efficiency declared on the energy label.

A number of gadgets and processes have been proposed to enhance the performance of washing machines without increasing energy or water consumption or wear on the textiles. These include: ozone treatment of the wash liquor (JLA products and Sanyo), ultrasonic agitation (Sanyo)[7], high performance osmosis / filtration (Ethos Partnership) and steam cleaning (LG).

Developments in the dry-cleaning industry have led to the introduction of novel solvents such as liquid carbon dioxide[8]. It is possible that similar developments could take place with home laundry given the necessary stimulus. Benefits of water and energy savings could arise from this.

Most washing machine manufacturers have stopped fitting mechanical programme controllers and replaced them with electronic controllers. The electronic controllers are more versatile and have the potential to link into smart home systems, provided they have a suitable communication port. Smart home systems offer the potential for energy savings by for example, timing the operation of the washing machine to coincide with the availability of solar heated water or some other intermittent supply of renewable or lower carbon energy. An internet connection also allows the performance of the appliance to be monitored remotely so that failing components can be identified and replaced when they start to cause a reduction in energy or water efficiency or cleaning performance.

Electronic controllers also allow the fitting of features such as those that indicate load weight as the laundry is placed in the drum and provide recommendations for detergent dosing. These assist the user to operate the appliance more efficiently.

[7] www.sanyo.co.jp/koho/hypertext4-eng/0602/0202-1e.html
[8] Seiter, M: Textile cleaning in cyclosiloxane, WfK detergency conference, Dusseldorf 2005

1.4 Additives

Compared to the energy consumed by the washing machine directly during a wash, the energy used in the production and distribution of detergents is substantial. It is estimated that the production and distribution of additives such as detergents and fabric conditioners gives rise to 12 % of the CO2 emissions associated with the whole washing process[9] (Data from years 2000 - 2001). The potential for energy wastage through overdosing of detergent is therefore considerable.

In the 1997, the industry made an unsuccessful attempt to move the UK market to concentrated detergents that required less packaging and lower transport costs. This has been followed up by the more successful ‘Washrite’ campaign in which the detergents have been concentrated progressively over a period of years. Currently, the market is diversifying into tablets, liquids and capsules. The concentrated detergents and new packaging formats of tablets and capsules have reduced waste further by helping the user to dose more accurately. However, since the choice to the consumer using these formats is essentially ‘one tablet / capsule or two’ there may be scope for further savings with systems that match detergent dose more precisely to the needs of the wash.

Advances in detergent chemistry have led to improved cleaning performance at lower temperatures, helping to reduce the energy consumption of the washing process.

[9] G. Van Hoof, E. Saouter, D. Kolokotsas & D Schowanek: CO_2 reduction potential for laundry detergents analysed by life cycle analysis. (Procter & Gamble) http://www.is4ie.org/images/Schowanek_poster.pdf

1.5 Textiles

The large volume of fabrics on the market that specify a maximum wash temperature of 40°C or less is helping to save energy by ensuring that lower temperature wash programmes are used.

Textiles that have stain repellent or self-cleaning properties require washing less frequently and may require milder, lower temperature wash programmes. Such textiles are currently available in specialised markets (for example, sportswear) where a coating has been applied to cotton fibres that repels water and resists staining. Examples of these fabrics include Hanes "Stayclean", Jerzees "Spotshield" and Hornung Mills "Cotton Plus".

Stain resistant coated textiles using products such as 'Scotchguard' and 'Teflon' have been available for many years but it is only in the last five years that advances in technology have given the finished textile improved 'handling' and this has led to broader acceptance across the market.

Another benefit of textile coatings can be crease resistance, which is not only attractive to the consumer in terms of convenience but also saves energy by reducing the need for ironing.

Recent innovations in textiles include a number of surface coatings that not only resist staining but also catalyse the breakdown of soils in the presence of sunlight. Examples of these include polyglycidyl methacrylate activated with silver nano-particles and a nano-coating of titanium dioxide developed by John Xin of Hong Kong Polytechnic University[10].

1.6 Commercial laundries

Only a very small proportion of consumers use commercial laundries rather than their own washing machine. Potentially commercial laundries can offer savings of up to 52% on energy, 73% on water and 85% on detergent.[11] Apart from specialist services such as nappy washing, commercial laundries have not penetrated the domestic market significantly. This is probably due to the high prices charged because of the high cost of labour.

[10] http://www.polyu.edu.hk/cpa/polyu/hotnews/details_e.php?year=2006&news_id=964
[11] Report by the European Textile Services Association http://www.etsa-europe.org/Etsa-Europe.org/homefs.htm

2 Drivers

2.1 Washing machine energy label

Since its introduction in 1996, the energy label has been the prime driver bringing about improvements in energy efficiency. By 2005, the UK market became virtually saturated with A class washing machines leaving no further incentive in the energy label for improving energy efficiency. In response to this, the washing machine manufacturers have extended the range of the energy label with the creation of an unofficial A+ class. This has improved differentiation at the higher levels of efficiency for the short term, but a more fundamental reclassification of the energy label will be required by 2008 to ensure that it still provides the incentive for the development of more energy efficient washing machines.

The Energy Saving Recommended (ESR) scheme operated by the Energy Saving Trust focuses attention on the most efficient and effective washing machines. Currently washing machines can qualify for ESR status if they have an energy label with A class energy efficiency, cleaning performance and spin-drying performance. The dependence of this scheme on the energy label means that it also requires revision in order to stimulate further advances in energy efficiency.

2.2 Technology

Technical development of the washing machine is no longer being driven by the energy label and so is encouraged only by the competition between rival manufacturers. Experience has shown that the industry struggles with the introduction of radical changes to design such as with the Dyson Contrarotator. The slow uptake of products such as this can only serve to inhibit anything other than very cautious development. On the positive side, competition from manufacturers in the Far East has put some pressure on the traditional European manufacturers. For example, LG led the trend towards larger capacity washing machines (though this was not necessarily an energy saving feature) LG was also the first manufacturer to offer the steam clean feature. LG also produced the WM 16100 FD, the first internet-ready washing machine that could be coupled into smart home systems. In 2005, Sanyo introduced the AWD-AQ1 washing machine that claimed to offer waterless cleaning programmes using ozone as the cleaning agent. It also had the ability to recycle water used in conventional washing cycles. The effectiveness and energy efficiency of this product has yet to be assessed by a third party.

2.3 Number of households and household size

The number of households in the UK is increasing and expected to continue to do so for the foreseeable future. Unless lifestyles change, it is most likely that the majority of these households will own a washing machine. Sales of washing machines are therefore expected to increase. On current trends, these washing machines will be larger capacity (6 to 7 kg) because people want to be able to wash larger items. At the same time, household size is decreasing. This could mean that people use their washing machines less frequently but wash larger loads. But in practice, the requirement for a faster turn round on some items means that laundry may be washed in smaller loads. Consumer demand should therefore be for more washing machines with a large capacity but with the ability to adapt to wash smaller loads efficiently.

2.4 Additives

There are voluntary agreements on minimising detergent packaging and on encouraging consumers to use the correct detergent dose (the Washright[12] scheme). Detergent manufacturers provide information to consumers on how to estimate the detergent dose on the basis of water hardness, the degree of soiling and the size of the load. This is dependent on the consumer's understanding of these three factors and inadvertent incorrect dosing is liable to occur. It is possible that automatic dosing systems could overcome this problem if fitted to washing machines. Such systems are commonly used in industrial laundries and a domestic variant has been developed. As the device was not commercially successful it is no longer available. An assessment could be undertaken to determine whether automatic detergent dispensers are more accurate than the consumer and can significantly reduce detergent consumption. A case could then be made for encouraging their introduction if appropriate.

2.5 Textiles

More widespread use of stain-repellent and self-cleaning textiles could lead to savings in water and energy through reduced frequency of washing. Promotion among fashion designers might help to increase the penetration of these products into to the mainstream. Other drivers are unlikely to have much effect in an area where people's choices tend to be swayed by fashion.

2.6 Commercial laundries

Energy savings through economies of scale and possibilities of recycling hot water make commercial laundries an attractive alternative to domestic washing in terms of energy and water efficiency. This benefit would have to exceed the additional costs of delivery and collection and outweigh any inconvenience that this would entail. A full lifecycle cost analysis is needed to evaluate the benefits that commercial laundries might offer. Expansion of the commercial laundry into the domestic sector could be driven by new higher density housing with small kitchens having no space for washing machines. But the culture change required and issues of cost to the consumer need to be addressed first. Furthermore, there would need to be a set of policies setting requirements for energy and water efficiency in commercial laundries.

3 Suggested goals

All the goals set out below must be considered in terms of their full environmental impact to ensure that gains in energy and water efficiency in domestic laundry washing are not made at the expense of related processes such as manufacturing, distribution and waste disposal. This also means that energy and water costs associated with peripherals such as detergents and the laundry drying process should be taken into account.

3.1 Energy Label

The energy label should be enhanced so that it provides further incentives to encourage industry to produce washing machines that operate more efficiently under the full range of programmes and load sizes that the user requires.

[12] www.sustainable-cleaning.com/en_washright.html

3.2 Load size

- Develop information programmes to modify consumer habits in the direction of filling washing machines as full as possible by 2008.
- Develop washing machines that are more responsive to load size so that they retain their efficiency when operated with smaller load sizes by 2010.
- Revise the energy label standard to include a factor to account for the ability of the washing machine to adapt efficiently to smaller loads by 2008.

3.3 Lower temperature

- Achieve greater use of lower temperature programmes by information campaigns to consumers by 2008.
- Revise the energy label standard to include low temperature cleaning performance by 2008
- Develop ozone and/or ultraviolet light and ultrasonic agitation processes to improve washing performance at lower temperatures by 2020
- Amend the energy label to include higher classes of energy efficiency to encourage the development of washing machines with the ultra low temperature features described above.
- Amend the energy label to specify a minimum temperature for the 60°C cotton programme.

3.4 Detergents

- Assess the potential for demand-led detergent delivery systems in washing machines to optimise detergent use and reduce wastage by 2008.

3.5 Water use

- Develop filtration systems that will allow the reuse of water in the washing machine by 2008
- Introduce washing processes based on novel solvents (in place of water) by 2020.

3.6 Technology

- Require manufacturers to fit a display to washing machines that tells the user on the basis of the weight of the laundry added and the type of programme selected, how efficiently the washing machine will operate. At the end of the cycle, the display would then show how much energy had been used. This gives the user some information so that they can modify the way they use their washing machine to optimise its operating efficiency.
- Introduce a completely new design of energy efficient washing machine, for example, with a waterless washing process, by 2020
- Develop ‘stay-clean’ textiles and extend their application into mainstream apparel and bedding by 2015.
- Ensure washing machines are designed to be compatible with recognised interface standards to allow them to be integrated with ‘smart home’ management systems by 2008. Put limits on any standby energy consumption associated with the smart home connection.

3.7 Infrastructure

- If the evidence from lifecycle analysis justifies the use of commercial laundries rather then domestic washing machines, then the establishment and widespread use of neighbourhood commercial laundries should be encouraged. This could be initiated through government-funded small business start-up schemes. Only businesses with energy efficient systems would qualify for the scheme. Consideration should be given to including community laundries in new-build residential developments.

4 Effect on MTP scenarios

4.1 Load size

- Changing consumer habits in the direction of filling washing machines as full as possible by 2008 might reap a 10% benefit on energy and water from those who adopt the new habits – assume this to be 20% of owners. The effect would happen relatively rapidly over the course of a year but may fade with time as people revert to previous habits.
- Developing washing machines that are more responsive to load size so that they retain their efficiency when operated with smaller load sizes by 2010 may achieve a benefit of 15% on energy and water. The impact will be delayed until the new designs are perfected and manufactured and then there will be a lag of 12 years before the majority of washing machines have been replaced.

4.2 Lower temperature

- Achieving greater use of lower temperature programmes by information campaigns to consumers by 2008 could yield energy savings of up to 25% on each wash. Assume 20% of owners are able to reduce temperatures on 25% of their washes. The effect would happen relatively rapidly over the course of the year.
- Revising the energy label standard to include low temperature cleaning performance by 2008 would lead to washing machines having better performance at lower temperatures by 2010. This could increase the proportion of washes that could be carried out at lower temperatures from 66% to 80% and the proportion of owners adopting the change might increase from 20% to 60% but only over the course of 12 years as old models are replaced by new.
- Developing ozone and/or ultraviolet light and ultrasonic agitation processes to improve washing performance at lower temperatures by 2020 would allow all users to reduce the wash temperatures of all their washes cutting energy consumption by 25% but only over the course of 12 years as old models are replaced by new.

4.3 Detergents

- Developing demand-led detergent delivery systems in washing machines to optimise detergent use and reduce wastage by 2015. Could reduce detergent consumption by 15% but only over the course of 12 years as old models are replaced by new.

4.4 Water use

- Developing filtration systems that will allow the reuse of water in the washing machine by 2008 could reduce water consumption by 50% over 15 years.
- Introducing washing processes based on novel solvents (in place of water) by 2020 would reduce water consumption to zero and remove all sewage treatment costs. However some form of waste disposal would still be necessary.

4.5 Technology

- Introduce a completely new design of washing machine by 2020
- Developing 'stay-clean' textiles and extend their application into mainstream apparel and bedding by 2015 could reduce use of the washing machine by up to 5% and would help with the transfer to lower temperature programmes described above.
- Agreeing standard interface and communication protocols to allow washing machines to integrate with 'smart home' management systems by 2008 could yield energy savings of up to 50 %, but this would be dependent on the parallel introduction of domestic renewable energy systems and thus would not have a significant impact until 2015 or 2020.

4.6 Infrastructure

- Encouraging the establishment and widespread use of neighbourhood commercial laundries in place of domestic washing machines by 2008 might attract 10% to stop using the washing machine at home. But the benefits in terms of energy and water savings are not yet known.

4.7 Projected energy consumption up to 2020

The values shown below are estimates based on the ideas discussed in this paper.

Date	Annual consumption (TWh)
Today	4.8
2008	4.6
2010	4.5
2015	3.9
2020	3.1

5 Critical issues

5.1 Pure research to be carried out before new products can come to market

- Research into completely novel designs of washing machine.

5.2 Applied research to be carried out before new products can come to market

- Research into systems for dosing and regulating detergent levels in the wash liquor.
- Research into the use of novel cleaning systems such as ozone.
- Research into the effectiveness of detergent dosing systems at reducing detergent consumption.
- Lifecycle analysis of the benefits of community laundries.

5.3 Legislative changes required

- Changes to EU energy label could include
    1. a low temperature programme
    2. a minimum temperature specification for the 60°C cotton programme
    3. a measure of ability to adapt to a small load efficiently
    4. re-grade the energy label energy efficiency classes so that for example, the current 'A' becomes a 'D' and the new 'E' class becomes the minimum energy efficiency class for all washing machines on the market.
- An agreement needs to be struck with washing machine manufacturers to ensure that they install energy efficiency information displays on their appliances.

5.4 User behaviour change

- Run education programmes to promote the wider use of low temperature wash programmes
- Run education programmes to promote the advantage of filling the washing machine to capacity.

6 Actions

Energy and water consumption and consequent carbon dioxide emissions associated with domestic laundry washing could be reduced through the following measures:

The European Commission could be called upon to modify the energy label to include the 40°C cotton wash programme and include a feature that promotes the development and sale of washing machines that automatically adapt efficiently and effectively to the size of the load.

Information campaigns could be initiated to educate consumers on how to use their washing machines efficiently and effectively.

Discussions could be held with CECED and other manufacturers to agree a way to ensure that energy efficiency displays are installed on all washing machines.

Research could be encouraged into novel laundry systems and into features that can enhance the energy and water efficiency of conventional washing machines. Research is also needed to re-examine the feasibility of automatic detergent dosing systems in washing machines.

A comprehensive life cycle analysis of the use of commercial laundries by domestic consumers could be carried out and compared with a similar analysis of domestic laundry. If the life cycle analysis indicates there is a significant carbon benefit to be gained from commercial laundries then the Department for Communities and Local Government could set up a pilot scheme to determine whether the predicted benefits can be realised.

Related MTP information

- BNW05: Assumptions underlying the energy projections for domestic washing machines.
  http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=125
- BNW08 Energy and performance test methodologies for domestic washing machines and washer dryers.
  http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=223
- BNW14 EU Energy Labelling of Washing Machines
  http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=232
- BNW15 Washing Machines efficient use FAQs
  http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=233
- Policy brief: UK energy consumption of domestic washing machines.

Changes from version 1.1: Minor editorial changes.

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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