

# BNW16: A comparison of manual washing-up with a domestic dishwasher

Version 2.5

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 Scope

This Briefing Note compares the energy and water consumption for manual washing-up with using a domestic dishwasher. The conclusions take into account real use of a dishwasher and that washing up habits vary widely.

## 2 Summary

- Dishwasher appliance water consumption can be three to four times less than washing the same amount of crockery and cutlery by hand.
- No claims can be made for energy efficiency because comparisons depend on precise washing up habits, loading of the dishwasher and the particular home plumbing for heating hot tap water.
- Items cleaned in a dishwasher are cleaner compared with washing by hand.
- Barriers to UK ownership include lack of space and wrong perceptions.
- Washing up habits vary widely, with some users using a lot of water.

## 3 Research

Some of the analysis in this Briefing Note is based on a study carried out by Bonn University<sup>1</sup>. This Briefing Note will concentrate on UK data; data from other countries are for interest. Dishwashing habits (manual or machine) vary widely and therefore make any conclusion open to debate. Any actual energy and water savings clearly depend on individual habits.

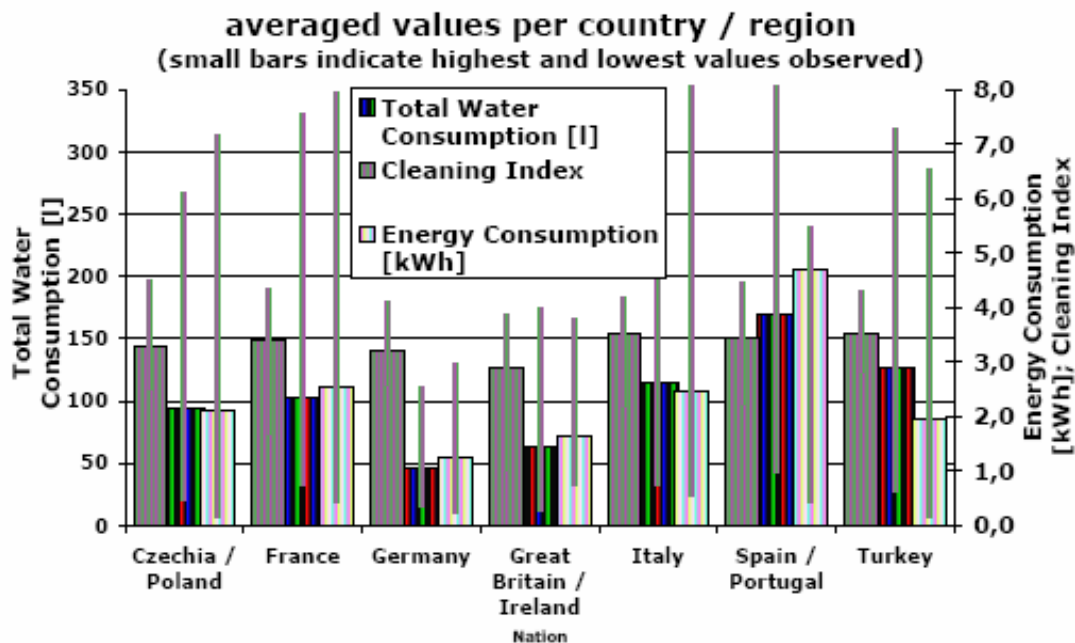
The Bonn University team observed the habits of users in seven countries across Europe. Water consumption, energy used and the effectiveness of cleaning were studied. This also allowed for a comparison with an automatic full size (12 place setting) AAA dishwasher (A energy consumption, A cleaning performance, A drying performance).

<sup>1</sup> *A European Comparison of Cleaning Dishes by Hand*, Rainer Stamminger et al c. 2003.

The test was similar to the standard test normally carried out for the energy labelling of domestic dishwashers. 140 items with seven different soils: egg, spinach, oatmeal, milk, minced beef, tea and margarine were prepared and dried in air for two hours. Volunteers washed these items while water consumption, energy, task duration and quantity of washing up liquid were measured. After washing, items were assessed for cleanliness.

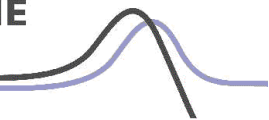
Figure 1 below shows resource consumption for the European study. Average and range of results are indicated. For each country / region, the first bar is cleaning index, the second bar is water consumption and the third bar is energy consumption.

Figure 1:



The long range bars for each result show that washing up habits within one country are extremely variable. As with many consumer habits, few are 'average', people adopt different habits often without thinking about or varying what they do. Figure 1 shows habits across Europe vary widely too.

Average results are shown in [Table 1](#) below:



**Table 1: Summary of manual washing across Europe**

Country	Water [l]	Energy [kWh]	Cleanser consumption [g]	Cleaning Index	Time [min]
D	46	1,3	21	3,2	76
Pl / Cz	94	2,1	21	3,3	92
I	115	2,5	70	3,4	76
E / P	170	4,7	37	3,4	79
Tr	126	2,0	34	3,5	106
F	103	2,5	39	3,4	84
GB / Irl	63	1,6	26	2,9	65
total	103	2,5	35	3,3	79
Dishwasher ('Normal' and 'Intensive' program)	15 - 22	1,0 - 2,0	30* *:different chemistry	3,3 - 4,3	Loading and unloading: ca. 15 Program time: 100 - 150

## 4 Cleaning

The cleaning index is assessed in exactly the same way as for dishwashing appliances. Each item is given a score (0 to 5) according to the amount and size of soil in accordance with EN 50242, the domestic dishwasher standard (5 means no residue of soil, 0 means total soil residue > 200 mm<sup>2</sup>). For the UK, the cleaning index is less than 3 and between 3 and 3.5 for other European countries. A dishwasher with A-class cleaning performance would have a cleaning index of approximately 4. From this study, we (the UK) are the dirtiest in Europe!

## 5 Water savings

The average UK water consumption to wash up these 140 items or 12 place settings by hand is 63 litres or 9 medium-sized bowls of still water. Those who wash all or part under running water could be using more than 150 litres. This additional water is used for pre-soaking before washing and/or rinsing after washing. User habits vary widely, some change the bowl of water frequently and some keep the same dirty water. The water consumption for a dishwasher is typically less than 20 litres and often less than 15 litres. In 2006 90% of full size dishwashers use 18 litres or less for some or all programmes. Based on the figure of 63 litres, washing the same load by hand uses at least three times more water than a dishwashing appliance. It could be argued that hand washing 12 place settings in one session is not realistic, but there is no survey information about what people actually do at home.

The lower water consumption for a dishwasher might infer a detergent residue problem. According to Unilever<sup>2</sup>, detergent residues are either zero or too small to be measured owing to the high dilution. According to a presentation in 2003<sup>3</sup>, there is more surfactant left on your teeth after brushing than surfactant at the end of dishwashing.

**Figure 2: Water consumption – dishwasher vs washing-up**

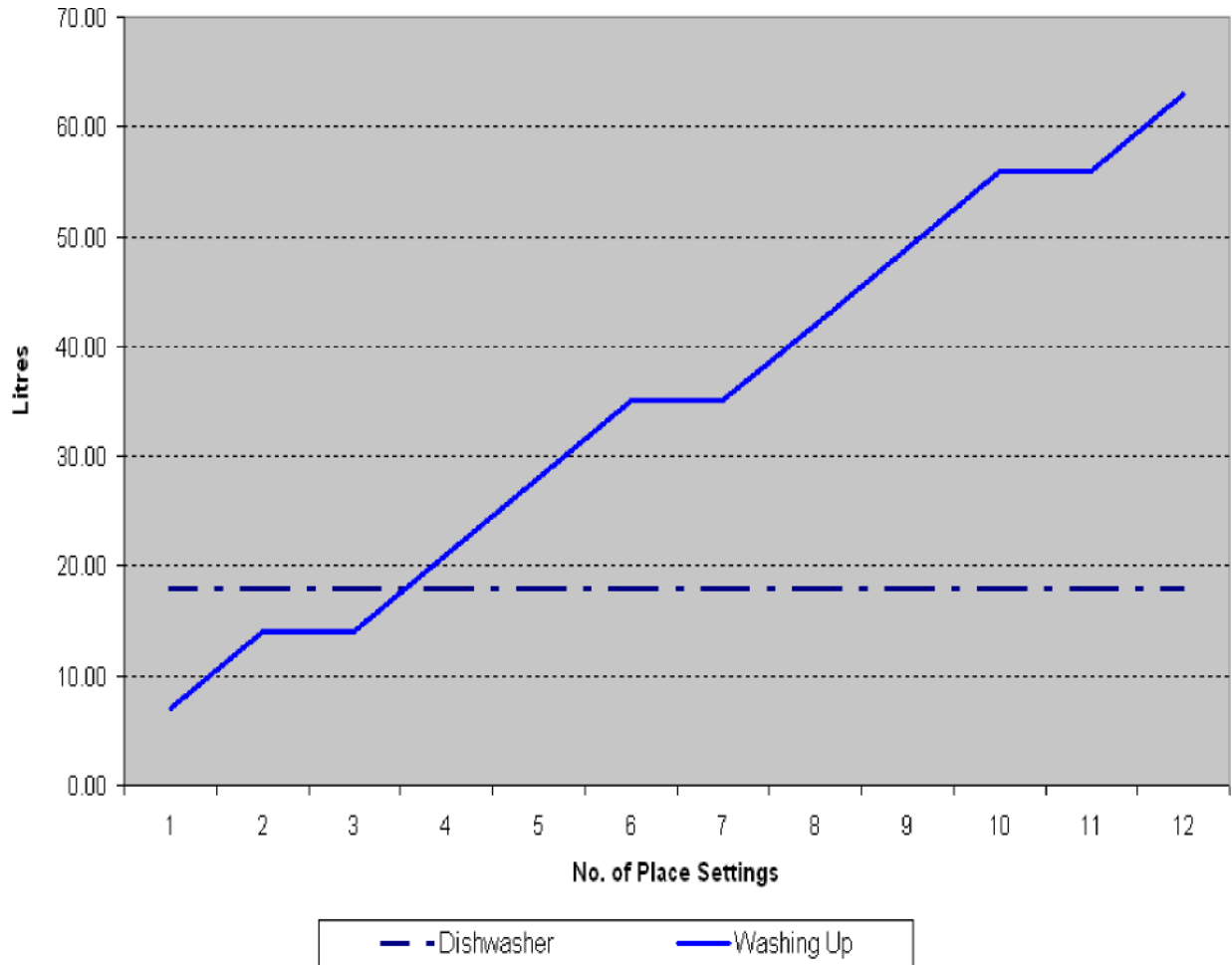
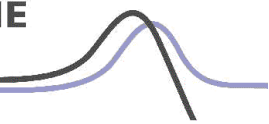


Figure 2 compares water consumption for manual washing-up with a dishwashing appliance. A dishwasher uses the same amount of water no matter what loading, whereas washing more items by hand demands more water depending on the frequency of changing the bowl water. For this comparison it is assumed that the bowl water is changed nine times to wash 140 items. While some dishwashers have a claim that water consumption is adjusted according to the amount of soil and crockery load, tests at Intertek RPT have not shown significant differences in water consumption. Some dishwasher users have a habit of rinsing crockery before placing in the dishwasher when it is only necessary to scrape the residue.

Even washing only four place settings by hand is more wasteful than a dishwasher. There is a strong case to use a domestic dishwasher to save water.

<sup>2</sup> Discussion with Willem Oldenburg, Unilever.

<sup>3</sup> International Detergency Conference, Dusseldorf; Presentation by Sarah Innes, University of Bonn.



## 6 Energy

For the Bonn study the water was heated via an instantaneous electric water heater. This Briefing Note compares a more typical system via a standard gas boiler. Of UK homes, 75% are heated via a gas boiler with a typical 70% efficiency. The energy required to heat 63 litres of washing up water from 15°C to 55°C is 4.2 kWh<sup>4</sup> but to fairly compare a fuel with electricity, 4.2 kWh must be divided by 2.5 to account for the relative inefficiencies to supply electricity compared with supplying gas<sup>5</sup>. For comparison, the energy consumption of a dishwasher is taken to be 1.283 kWh for new 'stock' (2006 values)<sup>6</sup>. A whole stock average is likely to be a higher energy.

**Figure 3: Energy consumption – dishwasher vs washing-up**

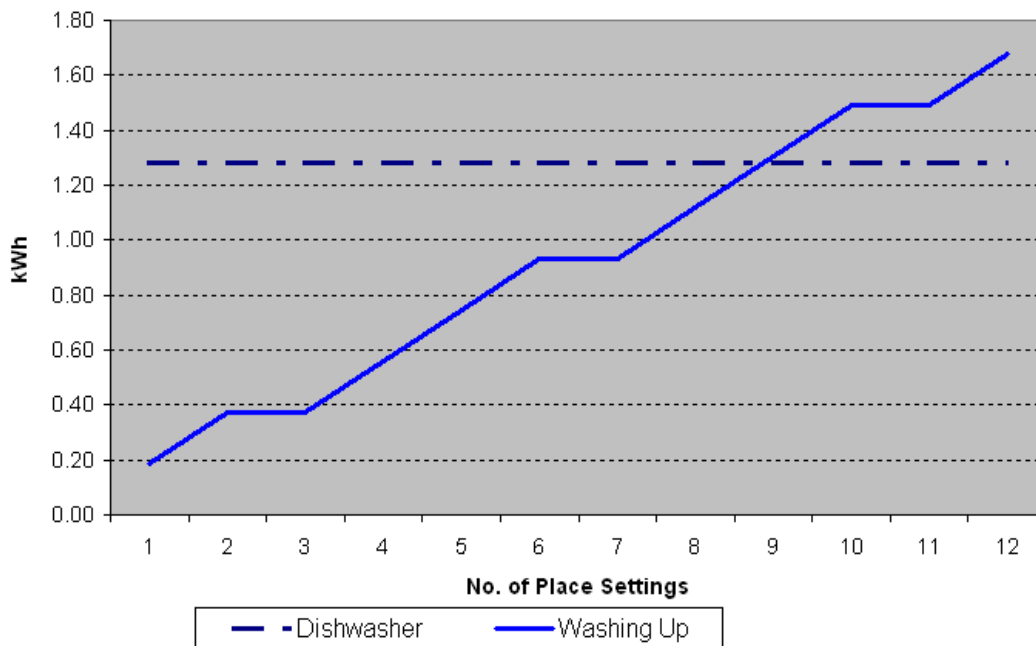


Figure 3 compares energy consumption for manual washing-up with a dishwashing appliance. A dishwasher uses the same energy no matter what loading, whereas washing more items by hand demands more energy depending on the amount of hot water used. (Tests at Intertek RPT show that a partly loaded dishwasher uses the same energy as a full one).

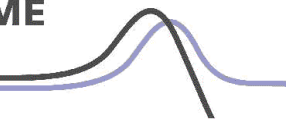
The value for water heating does not take into account inefficiencies (eg. heat losses) other than the gas boiler, because this is so dependent on individual home plumbing. For hand washing, many users wear gloves and therefore can use the hottest water available, though this may not be at 60°C.

From the energy consumption graph above, the crossover between hand washing and a dishwasher appliance is nine place settings. When considering that most

<sup>4</sup> From Energy = heat capacity x temp rise / (3.6 x 106 x 70%).

<sup>5</sup> Discussion with Bruce Young, Building Research Establishment. Some experts state supplying gas is nearly 3 times more efficient than supplying electricity.

<sup>6</sup> 1.283 kWh from MTP 'What-if' tool.



dishwashers are loaded only to about seven place settings <sup>7</sup>, these figures show that using a dishwasher does not save energy. A dishwasher either looks full from not being loaded efficiently or has a few larger 'cookware' items which take up space. Sometimes the dishwasher is run part full simply because the user would like to use some items fairly soon and does not have two sets of crockery to fill the dishwasher to a 12 place setting capacity, and some users do not like food residue smelling after sitting in the dishwasher for a day. (Some dishwashers have a rinse-only programme which helps remove food residue but uses more water of course.)

However, more efficient dishwashers and lower temperature washes proffer a potential saving. For an A rated energy appliance, the crossover occurs at seven or eight place settings.

Slimline dishwashers (eight or nine-place settings) use nearly the same energy as a 12 place machine, so there is no energy advantage if they are similarly under-loaded.

In summary, there is not a strong case for or against using a dishwasher to save energy. This is contrary to some marketing claims.

## 7 Other considerations

### 7.1 The energy to supply water

Any energy discussion should also include additional energy to supply water and to remove waste. Washing in a dishwasher gives an approximate saving of 45 litres (60 – 15) compared with the same amount of crockery/cutlery washed by hand. From BNW07 <sup>8</sup>, a dishwasher is used about 248 times a year. This represents a saving of 11 160 litres per household or 81 350 million litres for the estimated 7.29 million homes which have a dishwasher. Since 1000 litres requires an estimated 0.83 kWh <sup>9</sup> for supply and disposal, the energy saving for not moving this water is 67.5 million kWh (equivalent to 10 700 tonnes of carbon <sup>10</sup>). While any saving is to be welcomed, this energy is nearly 40 times smaller than the energy to run dishwashers themselves and a drop in the ocean compared with the energy to supply water for all domestic use. There is still not a strong case to use a dishwasher to save energy.

### 7.2 Hygiene

Washing in a dishwasher is generally more effective (fewer soil 'spots') and more hygienic (lower bacteria count) than by hand. Depending on programme selected, appliance hot water is 60-65°C throughout the wash cycle. For hand washing, people in the UK tend to use only hot water at 60°C or slightly colder but this quickly cools in an open bowl. A study by the University of Louisville School of Medicine showed an average bacteria count of 1 per plate for machine washed

<sup>7</sup> *Decade 2 MtC* (Domestic Equipment And Carbon Dioxide Emissions – Two million tonnes of carbon, Oct 1997) page 63.

<sup>8</sup> MTP Briefing Note BNW07 Assumptions underlying the energy projections for domestic dishwashers

<sup>9</sup> 0.83 kWh/1000 litres – information from Kevin Lane, AEAT.

<sup>10</sup> Value calculated from carbon emission factors in MTP Briefing Note BNXS01c v.2.2.

dishes compared with an average of 390 per plate for dishes washed by hand <sup>11</sup>. Automatic dishwashing is required by law in Hospitals and other institutions in the United States.

## 7.3 Detergents

The impact of dishwasher detergents on the environment has not been factored into this Briefing Note. Any complete comparison should take into account the overuse of detergents when washing by hand and the strong detergents used in a dishwasher.

## 8 Barriers to dishwasher ownership

Current UK ownership is nearly 28% of homes <sup>12</sup>; the remaining 72% may not have a dishwasher for the following reasons:

- Cost: not all householders will have a dishwasher high on their priority list even though cheaper appliances are around £200 or less.
- Some perceive these appliances to be wasteful with energy and water and not good at cleaning.
- Space: many UK homes do not have sufficient kitchen or utility space for another appliance. (Of UK homes, 40% have a tumble drier so after a fridge and washing machine, ie. that one additional 'appliance space' is more likely to be filled by a tumble drier.)
- Small family unit – taking too long to fill large dishwasher appliance.

For comparison, dishwasher ownership in Germany and the Netherlands is around 50%.

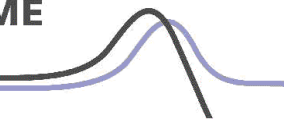
## 9 Recommendations / conclusions

Using a dishwasher is not inherently wasteful providing it is used efficiently. Indeed, it can save water and be cleaner than washing by hand. However, claims that dishwashers are more *energy* efficient than hand washing are sometimes made and have no foundation.

To save water and have better energy consumption, users should load their dishwasher appliance as fully as possible and use the energy label programme (or eco-programme) which usually washes at a lower temperature. Since these programmes may take up to three hours, some consumers may prefer a shorter programme which is hotter but uses more energy. Other users run their appliance overnight when programme duration is not an issue. (Running any appliance overnight can be cheaper and creates a more even energy demand on the national grid. However, some consumers are concerned about noise overnight and safety when running appliances unattended.)

<sup>11</sup> [http://www.healthycleaning101.org/english/SDAC\\_autodish.html](http://www.healthycleaning101.org/english/SDAC_autodish.html)

<sup>12</sup> MTP Briefing note BNW07, *Assumptions underlying the energy projections for dishwashers*.



## Related MTP information:

BNW07 Assumptions underlying the energy projections for dishwashers:

<http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=173>

BNXS01c: Carbon Emission Factors for UK Energy Use:

<http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=150>

## Changes from version 2.4 of this Briefing Note:

Minor editorial changes including Section 5 – water savings.

## 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](mailto:info@mtprog.com) quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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