

URBAN-RURAL ON-CAMPUS SOLUTIONS: SUSTAINABILITY ACCELERATOR PROGRAM “HOT WATER PROJECT”

LEGISLATION AND RESEARCH REPORT

INTRODUCTION

We believe that unnecessary water and energy consumption arises from the provision of hot water generally across public facilities but potentially further afield. The aim of the GCSO Hot Water project, with King’s College London as one of three implementation partners, is to provide a scalable solution driving measurable carbon reductions that is supported by reliable research and evidence of carbon savings linked to energy and water consumption, through user engagement and technical solutions. The results will provide a tried and tested case to drive legislative change and recommend implementation methodologies.

The project approach aligns with the UK Climate Act which legally binds the UK to reduce carbon emissions by 80% of 1990 levels by 2050, and the HEFCE (Higher Education Funding Council for England) 2020 carbon reduction targets of 3% per year. The approach takes issue with the requirements of provisioning hot water, i.e., that a proportion of hot water in buildings is provided for comfort rather than hygiene requirements. In the current UK modus vivendi, it is estimated that a successful delivery of this test pilot could demonstrate that hot water consumption reduced by half, could yield a 3-4% carbon emissions reduction across the entire University Estate which, in turn, boosts confidence to meet the 2020 target.

CURRENT LEGISLATION - UK

There are two areas of regulation that apply to the provision of hot water in sanitary conveniences and washing facilities. The HM Government regulations 2010 (revised in 2016) (Table 1) indicate that provision for heated water is a requirement for specific areas, e.g., washbasins, showers and food preparation areas. Reference to adequate hand washing facilities related to sanitary convenience or to food preparation areas do not specify hot water as a requirement. The Health and Safety Regulation 21, however, stipulates that hot or warm water as well as cold water is a requirement of washing facilities to be considered suitable and sufficient.

Table 1. UK Regulation details	
Regulation	Key points
HM Government - The Building Regulations 2010 (2016 edition): Approved Document G - Sanitation, Hot Water Safety and Water Efficiency	G3: There must be a suitable installation for the provision of heated wholesome water or heated softened wholesome water to: (a) any washbasin or bidet provided in or adjacent to a room containing a sanitary convenience; (b) any washbasin, bidet, fixed bath and shower in a bathroom; and (c) any sink provided in any area where food is prepared. G4: Adequate hand washing facilities must be provided in: (a) rooms containing sanitary conveniences; or

Table 1. UK Regulation details	
Regulation	Key points
	(b) rooms or spaces adjacent to rooms containing sanitary conveniences. G6: A suitable sink must be provided in any area where food is prepared.
Health and Safety Executive (HSE) Approved Code of Practice, Workplace (Health, Safety & Welfare) Regulations 1992 (2013): Regulation 21 Washing Facilities	(1) Suitable and sufficient washing facilities, including showers if required by the nature of the work or for health reasons, shall be provided at readily accessible places. (2) Without prejudice to the generality of paragraph (1), washing facilities shall not be suitable unless – (a) they are provided in the immediate vicinity of every sanitary convenience, whether or not provided elsewhere as well; (b) they are provided in the vicinity of any changing rooms required by these Regulations, whether or not provided elsewhere as well; (c) they include a supply of clean hot and cold, or warm, water (which shall be running water so far as is practicable); (d) they include soap or other suitable means of cleaning; (e) they include towels or other suitable means of drying; (f) the rooms containing them are sufficiently ventilated and lit;

History of the legislation

The Factories Act (1961) and the Office, Shops and Railways Act (1963) precede the current regulations for health and safety in the work place. In both Acts, sanitary facilities and washing facilities are separated. No requirement exists for sanitary facilities to have hot water, but it is required in washing facilities, specifically focused on workers undertaking dirty work. In 1989, the EU published regulations stating that hot water is required 'if necessary' and it is from these regulations that the 1992 Health and Safety Regulations were drafted. Typically, EU directives are directly copied into UK law, but this was not true in this case. Sanitary and washing facilities requirements have been combined, whether a result of simplification or of gold plating, there is now an inclusion of hot and cold, or warm water in every sanitary convenience. The implication of this is a potentially unnecessary burden of 5% in carbon usage in all work places, as opposed to if only provided when essential. In Germany, an EU country with similar workplace requirements and climate conditions, the EU regulations have been directly implemented. This means that handwashing facilities must have running water and soap, the stipulated methods of drying hands, and the provision of hot water, if necessary. In addition, they include definitions of when hot water is deemed necessary in washrooms, which are facilities for workers undertaking dirty work.

CURRENT LEGISLATION - INTERNATIONAL

This international, collaborative project includes partners across eight countries. Several of these partner universities do not supply hot water to non-essential systems (see examples provided in Table 2), which also includes the European legislative directive.

Table 2: International Regulation details		
Country	Hot water Y/N	Regulation with Key points
China (Hong Kong)	No	Hong Kong building officials confirmed that codes relating to hot water are in Buildings Ordinance (CAP 123), and only specify requirements if hot water is used. In these cases, the codes reflect emphasis on pipes and materials. Note1: While a British colony, Hong Kong had the option of adopting British building codes and policies, and often did. Note2: On the issue of warm water for hand washing, Hong Kong decided not to adopt the British standard.
European Regulations	N/A	Council directive concerning the minimum safety and health requirements for the work place 89/654/EEC Section 18 Sanitary equipment – 18.2.3 'suitable washbasins with running water (hot water if necessary)'
Germany	No	"Arbeitsstättenverordnung TA A4.1 Sanitärräume" for sanitary facilities. More in detail ASR A 4.1 - 5.4: (2) Sanitary facilities (toilets) need to offer hand washing possibilities (washbasin providing water and closed drain) as well as rubbish bins. In addition, toilets need to provide measure for cleaning (e.g., soap in dispensers) and drying hands (e.g., one-way towels, hot air drying system, towels). If needed, additional hot water, as well as hooks for clothes, need to be provided. Note1: Meeting the regulation is not a 'must' but a 'can/should' depending on weighting. Note2: In case of Leuphana, hot water is considered essential in places where, e.g., organic impurities need to be cleaned (like the canteen). "Normal" buildings with cleaning personal are deemed to not need hot water, as many cleaning substances work without hot water.
Ireland	Yes	Statutory Instruments, S.I. No. 355 of 2008, Building Regulations (Part G Amendment) Regulations 2008. G1(c) Bathrooms and kitchens. A suitable installation for the provision of hot and cold water to the bath or shower bath, washbasin and sink. G2 (3) Sanitary conveniences and washing facilities. There shall be a suitable installation for the provision of hot and cold water to washbasins provided in accordance with subparagraph (2). Health and Safety Authority: Guide to the Safety, Health and Welfare at Work (General Application) Regulations 2007: Regulation 20: Sanitary and washing facilities 20. An employer shall provide and maintain and keep in a clean state — (a) adequate and suitable sanitary and washing facilities for the use of employees, (b) an adequate number of lavatories and washbasins, with hot and cold running water, near workstations, rest rooms, changing rooms and rooms housing showers.
Japan	No	There are no regulations on the temperature of the water supply in washing basins. Note1: Hot water is used due to comfort not hygiene reasons. Note2: Culturally hot water use has not been connected to hygiene.
USA	Yes	The Food Code of the U.S. Food and Drug Administration (FDA) recommends that hand-washing sinks be equipped to provide water at a temperature of at least 100°F (38°C).

HOT WATER, HAND-WASHING AND HYGIENE

Examination of scientific evidence reveals that water temperature has no bearing on the effectiveness of handwashing with regards to hygiene. Current practice has been led by outdated beliefs and comfort rather than scientific findings.

Scientific research

There have been numerous studies conducted on hand hygiene including research into the use of alcohol gels and best practise for hand washing. In June 2017, in the *Journal of Food Protection*, Jensen *et al.* published their recent findings of a study which included the effects of water temperature on handwashing in relation to hygiene. Widely publicised by the media, particularly in the British and American press, the results of this small study concluded that no significant difference was found in bacterial load in water temperatures ranging from 15°C to 38°C (Jensen *et al.* 2017).

Two other significant papers in this field include Michaels *et al.* (2002) and Carrico *et al.* (2013). The former investigated water temperature as a factor in handwashing efficiency to find that all currently employed handwashing practices are based on untested traditions with the results indicating that water temperature exhibits no effect on transient or resident bacterial reduction during normal handwashing with bland soap. They recommend that food service handwashing guidelines should not specify water temperature descriptors other than perhaps the word 'comfortable' when it comes to defining effective handwashing standards. 'Warm' or 'tempered' would probably also be acceptable (Michaels *et al.* 2002).

Carrico *et al.* (2013), examined the environmental cost to using elevated temperatures in handwashing. The conclusions were two-fold: In addition to contributing to skin irritation, using an elevated temperature during handwashing contributes to climate change (Carrico *et al.* 2013). Like Michaels *et al.* (2002), they recommend that health and consumer protection organisations consider advocating for the use of a 'comfortable' temperature, rather than warm or hot water (Carrico *et al.* 2013).

Best practice

There are several organisations that provide best practice guidelines for hand hygiene. Two of these are the World Health Organisation (WHO) and the UK National Health Service (NHS).

The 2009 *WHO Guidelines on Hand Hygiene in Health Care: A Summary* documents best practice on technique, water temperature, skin care and education. The WHO advocates for the use of clean, running water when washing hands, but against using hot water repeatedly, as this increases the risk of developing dermatitis (WHO, 2009). This risk was substantiated by the research of Carrico *et al.* (2013) who found that the use of hot water increases the risk of skin irritation.

In the NHS document *How to Wash Your Hands* (NHS Choices, 2016), the recommendation is to use warm or cold water. However, the *CG1 Standard Infection Prevention and Control Guidelines* for NHS professionals (NHS Professionals, 2013) indicates the use of warm water, but no reason is indicated. The use of tepid water is supported by guidance outlined by Loveday *et al.* (2014).

Behaviour and hand washing

Anger *et al.* (2016) reveal that occurrences of handwashing with soap is directly correlated to tiredness or busyness. In addition, they link occurrence with good manners.

In 2015, Berry *et al.* examined gender in relation to hand washing and found that the defining factor was urinal use by men, which lowered handwashing occurrence. Otherwise, men and women show similar results when

using the toilet. Research by Dawson *et al.* (2017) found that design features are important in encouraging hand hygiene including jet strength, water temperature and device affordance that may improve hand hygiene technology. This was supported by the findings of Berry *et al.* (2015) and earlier work by Naikoba & Hayward (2001).

Although most studies approach hand hygiene from the healthcare setting perspective, promotion of proper handwashing needs to be sustained long term rather than a single instance educational piece (Naikoba & Hayward 2001). In fact, the creation of a culture promoting hand hygiene at all levels of society goes beyond confining hand hygiene to healthcare alone (Jumaa 2005). From the domestic perspective, the hand hygiene message should focus on interrupting the transfer of microorganisms and the spread of infection rather than just killing microorganisms per se. This is different from the healthcare setting, where it is important to reduce the overall microbial load (Jumaa 2005). There are also significant issues in making global recommendations for hand hygiene due to cultural differences; recommendations must take both geography and cultural factors into account.

ISSUES OF HOT WATER RELATING TO HEALTH

Health risks associated with the storage and delivery of hot water to building occupants fall into two main areas of concern; scalding and legionella (HSE 2012; TMVA 2000). Both risks can be mitigated by the removal of hot water supplies to non-essential areas.

Scalding

The risk of scalding increases exponentially with temperatures above 44°C (HSE 2012). To mitigate the risk of scalding, the HSE (2012) recommends safe temperatures for delivery of hot water and the use of signage where users are at risk.

Legionella

Legionella bacteria proliferate between 20°C and 45°C and only die in temperatures above 60°C (HSE 2012; TMVA 2000). Measures to ensure Legionella is controlled include: maintaining a hygienic system; storing hot water at temperatures > 60°C; and distributing hot water supplies at 50°C, or above 55°C in healthcare settings (HSE 2012; TMVA 2000), which is well above the at-risk temperature for scalding.

CONCLUSIONS

The reasons for removal of non-essential hot water are strongly supported by the literature pointing to a needed change in regulations when examining the UK legal requirements against those of other EU member states. From a scientific standpoint, evidence from research studies and the WHO clearly show that the use of hot water for hand washing and in the promotion of hand hygiene is unnecessary and can, in fact, be detrimental to skin health. Whilst much of the scientific literature advocates for the use of warm water, it is not clear whether this is for scientific reasons or for user comfort. In an examination of the drivers of hand washing behaviours, key factors appear to be outdated beliefs or bathroom design, rather than health and hygiene. Any behavioural change would need to be promoted through a sustained programme of education for it to be effective long-term. From a savings perspective, both carbon emissions and cost would benefit from the removal across the UK Plc.

Initial estimates across the King's College London estate identifies a potential carbon emissions savings of 3-4% annually with an estimated significant corresponding cost savings. Initial results show that in the first pilot

building where hot water was temporarily removed as part of planned maintenance, there is a potential 20% carbon saving. In the other pilot buildings, carbon savings could range from 5% to 18% and financial payback between 2.5 and 7 years, depending on replacement point source installations. The on-going research will seek to verify these savings. In addition to direct savings from gas and electric use, operational and maintenance costs will be included in final calculations. An added benefit, identified from the scientific literature is that the exclusion of hot water from washrooms will aid in the prevention of Legionella and remove the risk of scalding.

Preliminary findings from research questionnaires show wide support for the initiative, with many respondents noting the reduction of greenhouse gas emissions and moral grounds as reasons for the support. In addition, the Student Union has challenged the Estates team to become carbon neutral, but Estates can only achieve this with their support. The Student Union has indeed shown interest in being part of the project and in championing it. In review of the evidence, it can be reasonably suggested that regulations should be altered to mitigate the installation of hot water in non-essential areas.

REFERENCES

- Aunger, R., Greenland, K., Ploubidis, G., Schmidt, W., Oxford, J., Curtis, V. (2016) The determinants of reported personal and household hygiene behaviour: a multi-country study. *PLoS ONE* 11(8), e0159551. doi:10.1371/journal.pone.0159551
- Berry, T. D., Mitteer, D. R., & Fournier, A.K. (2015). Examining hand-washing rates and durations in public restrooms: a study of gender differences via personal, environmental, and behavioral determinants. *Environment and Behavior*, 47(8), 923–944.
- Carrico, A. R., Spoden, M., Wallston, K. A. & Vandenberg, M. P. (2013). The environmental cost of misinformation: why the recommendation to use elevated temperatures for handwashing is problematic. *International Journal of Consumer Studies*, 37(4), 433-441.
- Council Directive. (1989). *Concerning the Minimum Safety and Health Requirements for the Workplace*. Directive 89/654/EEC - Workplace Requirements.
- Retrieved from: <https://osha.europa.eu/en/legislation/directives/2>
- Dawson, C. H., Mackrill, J. B., & Cain, R. (2017). Assessing user acceptance towards automated and conventional sink use for hand decontamination using the technology acceptance model. *Ergonomics*, 60(12), 1621-1633. <http://dx.doi.org/10.1080/00140139.2017.1316018>
- Factories Act. (1961). Chapter 34 9 and 10 Eliz 2. Retrieved from: <http://www.legislation.gov.uk/ukpga/Eliz2/9-10/34>
- Health and Safety Executive. (2013). *Workplace Health, Safety and Welfare – Workplace (Health, Safety and Welfare) Regulations 1992*. London, UK: Crown Copyright. Retrieved from: <https://www.aceconsultants.co.uk/wp-content/uploads/2016/09/l24-Workplace-Welfare-Regulations.pdf>
- Health and Safety Executive. (2012). *Hot and Cold Water Systems*. Retrieved from: <http://www.hse.gov.uk/legionnaires/hot-and-cold.htm>
- HM Government. (2016). *The Building Regulations 2010 – Sanitation, Hot Water Safety and Water Efficiency* (2015 Edition with 2016 amendments). Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/504207/BR_PDF_AD_G_2015_with_2016_amendments.pdf
- Jensen, D. A., Macinga, D. R., Shumaker, D. J., Belina, R., Arbogast, J. W., & Schaffner, D. W. (2017). Quantifying the effects of water temperature, soap volume, lather time, and antimicrobial soap as variables in the removal of *Escherichia coli* ATCC 11229 from hands. *Journal of Food Protection*, 80(6), 1022-1031.
- Jumaa, P. A. (2005). Hand hygiene: simple and complex. *International Journal of Infectious Diseases* 9, 3-14.

- Loveday, H. P., Wilson, J. A., Pratt, R. J., Golsorkhi, M., Tingle, A., Bak, A., Browne, J., Prieto, J., & Wilcox, M. (2014). Epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *Journal of Hospital Infection*, *86*(S1), S1-S70.
- Michaels, B., Gangar, V., Schultz, A., Arenas, M., Curiale, M., Ayers, T., & Paulson, D. (2002). Water temperature as a factor in handwashing efficacy. *Food Service Technology*, *2*(3) 139–149.
- Naikoba, S. & Hayward, A. (2001). The effectiveness of interventions aimed at increasing handwashing in healthcare workers – a systematic review. *Journal of Hospital Infection*, *47*(3), 173-180.
- NHS Professionals. (2013). *Clinical Governance 1 Standard infection prevention and control guidelines*. Retrieved from: <https://www.nhsprofessionals.nhs.uk/search?term=standard+infection+prevention>
- NHS Choices. 2016. *How to wash your hands*. Retrieved from: <https://www.nhs.uk/Livewell/homehygiene/Pages/how-to-wash-your-hands-properly.aspx>
- Offices, Shops and Railway Premises Act. (1963). Chapter 41. Retrieved from: <https://www.legislation.gov.uk/ukpga/1963/41>
- Thermostatic Mixing Valve Manufacturers Association (TMVA). (2000). *Recommended Code of Practice for Safe Water Temperatures*. London: TMVA.
- World Health Organisation (WHO). (2016). *WHO Guidelines on Hand Hygiene in Health Care: A Summary*. Switzerland: WHO Press.