TWENTY65

INTRODUCING BROAD-SCALE WATER METERING

The current evidence base and key action points to reduce personal water use in England and Wales

DR EMMA WESTLING
TWENTY65
THE UNIVERSITY OF SHEFFIELD

Contents

Executive Summary

- Evidence confirms that water metering can significantly reduce household water consumption, but the evidence is limited and includes only a few published cases that track actual water use following installation of water meters.

- Making greater use of water consumption data, where these data are based on robust collection methodologies, could strengthen the current evidence base.

- Consumption data across England and Wales show that metered households, on average, use less water compared to non-metered households. However, whereas metered household consumption data is measured, non-metered household consumption is based on estimates.

- Research conclude that households with existing lower water use are more likely to opt for meter charging, meaning that the total water consumption may not reduce significantly.

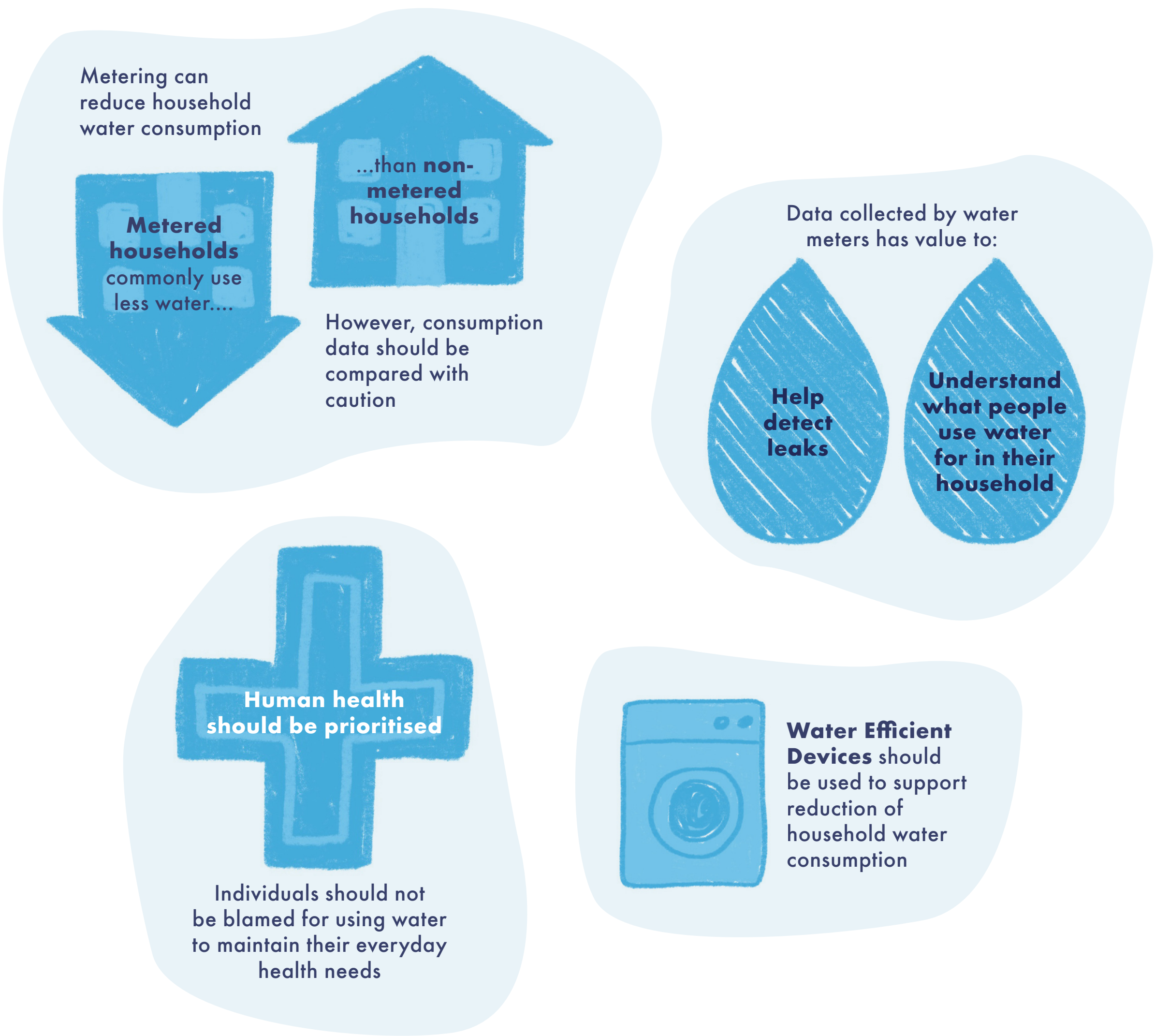
- Based on the current evidence base, the justification for broad-scale metering does not have to be constrained solely to water use reduction through behaviour change. There are opportunities to expand the justification to include enhanced leakage detection through metering, particularly for smart metering.

- Broad-scale smart metering installation has the potential to provide vital information about how and for what purpose people use water, information that could inform more targeted interventions. How the data is collected, analysed, used and owned needs careful consideration.

- Alongside installing broad-scale metering as a measure to reduce household water consumption, technologies such as water efficient devices should be introduced as a starting point. These can contribute to large reductions in water consumption without having to rely on people changing their behaviours.

- There is an urgent need to go beyond considering how much water that is used to also include why people use water. Innovative methods to enhance such understandings underpinned by a 'practice-based' approach has been suggested. Practice research highlight that people do not primarily use water in itself, but to perform an 'everyday practices' such as washing, cooking or gardening. Evaluating changes in practices could provide a better understanding of water use in the home and inform more targeted interventions.

- Access to clean water must be recognised as a health-based right. Communications around water savings need to distinguish between water efficiency and water wastage and individuals should not be blamed for using water to maintain their everyday needs. Framing water savings around communal goals beyond financial gains may be fairer and more effective in the long term in relation to water savings.



Background

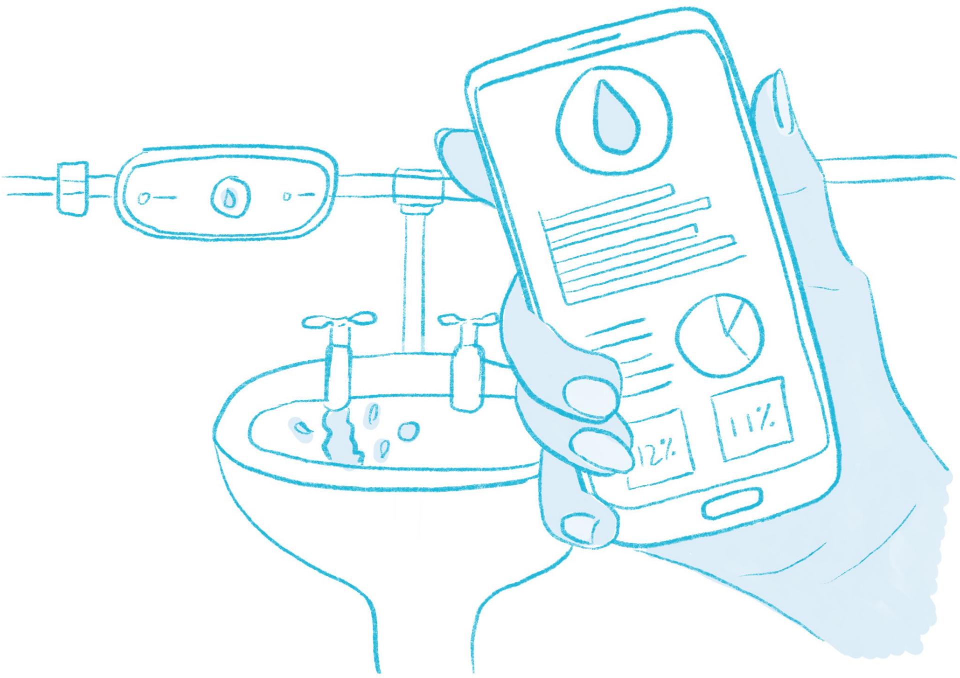
Introducing broad-scale metering has gained increased attention in the UK as part of addressing water scarcity through reducing household consumption (e.g. Ueda and Moffatt, 2013). Forecasts have suggested that smart metering, combined with a mandatory labelling scheme (with minimum standards), could result in a per capita consumption (PCC) of 82 L/h/d by 2065 (Artesia, 2019).

Research, underpinned by water consumption data in the UK and globally, conclude that water meters can significantly reduce household consumption (Tanverakul and Lee, 2015; Sønderlund et al., 2016; Ornaghi and Tonin, 2019). However, discussion related to wider implications and potential unintended consequences of broad-scale metering (e.g. related to health) has so far been limited. In addition, uncertainties related to diversities across a population (e.g. social, cultural, health-based needs), in terms of how and for what purpose water is used, will influence the effectiveness of metering as a means of reducing consumption. Monitoring real-world practices has therefore been highlighted as important, alongside having realistic ambitions about the extent to which individual changes can directly impact on water demand (Artesia, 2019). The overall aim of this briefing note is to highlight broader issues surrounding metering that need careful consideration in order to maximise the benefits and prevent unintended consequences of broad-scale metering in England and Wales.

Specifically, this briefing note seeks to: 1) present the current evidence base for the effectiveness of water meters in terms of reducing household consumption in England and Wales; 2) identify potential unintended consequences from a broad-scale implementation of water meters; and 3) provide key action points to be considered as part of introducing water meters as a measure to reduce household water consumption.

The evidence reported here is part of a larger review of measures to reduce personal water use. The full review followed the method for Rapid Evidence Assessments set out in Collins et al., 2015 and collated the evidence around water efficiency measures (metering, labelling and PCC targets) in terms of effectiveness, fairness and unintended consequences. All identified research was assessed in relation to relevance and methodological robustness. Research papers and reports that did not meet the required standard were not considered in the full review or in this briefing note. In addition, four expert interviews were conducted to address the most immediate evidence gaps emerging from the review, primarily in relation to unintended consequences of measures to reduce personal water use, including metering.

See below, a summary of the current evidence base related to the effectiveness of metering in terms of reducing water consumption in England and Wales, alongside broader unintended consequences.



Evidence review

In total, 35 journal papers and reports related to measures to reduce personal water use, were reviewed. The papers and reports were generated from searches of two academic databases (Scopus and Web of Science) and the Defra Science Search database. For this briefing, seven additional papers have been added, generated from focused searches associated with metering, as well as papers and reports recommended by the interviewed experts and the steering group for the evidence review.

EFFECTIVENESS

Research underpinned by predictions and scenario testing illustrates that broad-scale water metering has the potential to significantly reduce household water use (e.g. Artesia, 2019, Environment Agency, 2007). A number of studies of actual water use in England also demonstrate significant water use reductions following installation of water meters.

Drawing on water consumption data from Southern Water, Ornaghi and Tonin (2017) report water savings of between 16%-20% following the introduction of household water meters. As part of this research, data were analysed at the point of household contract switch to meter charging and then for the subsequent four bills (every six months over a 2-year time period). The report noted that a proportion (5%) of the reduction in water consumption related to the detection (and fixing) of leaks. Further, the data indicated that the reduction in water consumption was similar across different income groups, indicating that there are other possible motivations behind water savings beyond solely economic interests. This argument is consistent with other research arguing that environmental concerns can be more strongly correlated with water consumption reductions compared to either cost or convenience (Britton et al., 2013; Maas et al., 2017).

Drawing again on Southern Water consumption data for 150,000 customers between January 2011 and October 2016, Ornaghi and Tonin (2019) found a decrease in household water consumption of 22% following meter installation. This research again highlighted that the water use reduction was similar across income groups. However, whereas high-income households gained financially from switching to a new tariff system based on meter charging, low-income households saw an annual increase in their water bill of, on average, £20-£23 following the switch to meter charging. This conclusion is consistent with wider research related to metering and affordability, showing that high-income households with low occupancy benefit the most from meter charging (Walker, 2009; Owen et al., 2009; Zetland, 2016).

Zetland (2016) reports on a smaller study analysing Wessex Water consumption data for 6,000 households which concludes that the presence of water meters and volumetric charging reduced consumption by 15% (Pymer, 2012 in Zetland, 2016). The research noted that water meters and volumetric charging were particularly useful in encouraging households to fix leaks, change old appliances and reduce water use outdoors, (Zetland, 2016).

In relation to water consumption trends across the population in England and Wales between 2000 and 2011, research shows that metered water use is lower than the average water consumption (Committee on Climate Change, 2012). Metered consumption also tends to fall over time, whereas unmetered consumption has risen across the same time period (Committee on Climate Change, 2012). However, it should be noted that large regional differences in PCC exist, which on average account for a water use variation between 110-185 L/day/person. Also, comparisons between metered and unmetered households should be viewed with some caution. For example, whereas metred water consumption is based on actual measurements, unmetered consumption is only estimated. The estimates are based on measurements of 'deployable outputs, metered consumption and leakage' (Committee on Climate Change, 2012:67). Further, the authors highlight that households tend to opt for meter charging, meaning that the combined water consumption (metered and non-metered) may not reduce significantly.

Similar to Committee on Climate Change (2012), Owen et al. (2009) found that regional location and the presence of a meter were seen to influence water use behaviour in their research exploring the public's aspirations, assumptions and expectations around sustainable water use in the home in the UK. People in more water-stressed areas tended to be slightly more aware of water scarcity issues, but general awareness of water scarcity was low. Metering was thought to have increased water efficient behaviour to some extent, although the financial gains associated with reduced water bills were not sufficient to encourage a reduction in water use more broadly. The report concluded that increased levels of metering could encourage water saving, but that there are barriers to be overcome if uptake of metering is to increase. This was particularly prominent amongst families and larger households, for whom metering is unlikely, at present, to reduce water bills.

According to Walker (2009), water companies in England and Wales expect water consumption reductions of between 5-15% following meter installations and meter charging, as indicated in their Water Resources Management Plans. The author also notes that these estimates are uncertain because households respond to meter charging and water price in diverse ways.

However, justification for broad-scale metering as a measure to reduce water consumption has not only been suggested in terms of incentivising people to use less water, but also as a means of improved leakage detection both on supply pipes and within households (e.g. Walker, 2009; Zetland, 2016). According to Zetland (2016), water meters would not only improve the understanding of household water use, but also encourage households to repair detected leaks. In relation to leakage detection, it has been argued that smart meters offer additional benefits of alerting households or water companies to leaks more quickly, alongside providing a more detailed understanding of water use (Walker, 2019), which can underpin more targeted interventions to reduce water consumption.

Understanding how and why people use water (not only how much) is important to maximise the impacts of metering. This is because research has shown that interventions, such as metering, that are underpinned by behaviour change strategies focused on the individual might not be as effective as expected in terms of reduced water consumption (Browne, 2015; Hoolohan and Browne, 2016). One possible explanation for this is that people don't use water in itself, but as part of performing a practice (for example cooking or washing) and water use is underpinned by a complex web of norms (for example around cleanliness), habits and socio-cultural factors (Shove, 2010).

For example, Watson (2017) studied how measures to encourage households to reduce water use through information and installation of smart metering played out in practice in areas of London. The research found that water use was strongly underpinned by socio-cultural aspects that were not known prior to the intervention. Therefore, it is suggested that for interventions to be effective in the future, it is important that water companies are aware of the differences in social, cultural and economic situations beforehand.

Measures to reduce personal water use, if not fully and broadly considered, could result in unintended consequences related to human health and fairness. The following section considers the potential for unintended consequences as related to water efficiency measures.

UNINTENDED CONSEQUENCES OF WATER METERING

Unintended consequences of water meters and water efficiency measures more generally have been reported in relation to public health concerns (e.g. Dillon et al., 2016; Sønderlund et al., 2016). For example, Dillon et al. (2016) found transient, but significant, increases in lead concentration in the water supply post installation of water meters (peaks between 573 and 9,700 µg/L, far greater than the 10 µg/l UK standard). Their findings are based on the measured effects of a pipe rig test programme where water meters were installed into lead supply pipes, followed by a field study measuring the effects of the meter installations in four properties with lead pipes. Peaks in lead concentration were primarily due to the particulate lead fraction. The report suggested that lead concentrations in the water supply can effectively be reduced by flushing the supply system. Affected households should be advised to flush the system for 10 minutes immediately after the meter installation and then for two minutes at the first use of the kitchen tap for three days (Dillon et al., 2016). In general, water companies recommend households with lead pipes to flush the system before the first use (e.g. United Utilities, 2020). Although flushing is an effective measure to reduce the concentration of lead in drinking water, it could be seen as counterproductive to water efficiency messages and could have an impact on metered households with lead supply pipes, particularly for those on meter charging that may not flush the system before first use. Similar concerns have been highlighted in academic research papers arguing that reduced water demand may create risks to drinking water quality, due to reduced flow velocities through water supply networks and greater water residence time in supply systems (e.g. Sønderlund et al., 2016; Bedard et al., 2018).

Related to water consumption, research has highlighted the potential advantage of smart meters in providing real-time consumption data to consumers resulting in water use reductions (e.g. Savic, et al., 2014; Sønderlund et al., 2016). However, these types of underpinning assumptions, i.e. expecting that more detailed information would automatically result in a change to water use behaviour, have been widely criticised (e.g. Shove 2010; Browne, 2015; Watson, 2020). One reason for this is that water is primarily used to perform 'everyday practices' (Browne, 2015), such as showering, cooking or gardening, with little reference to actual water use in litres. Water is instead used to fulfil a certain practice which in turn is underpinned by social norms, habits and socio-cultural factors (for example gardening and the norm of maintaining a green lawn). Therefore, without understanding why and how water is used, interventions such as metering are less likely to reach their full potential in terms of enabling water use reductions. On the other hand, broad-scale smart metring installations could provide vital information about how water is used in the home, enabling better understanding of trends in water consumption and allowing for more targeted interventions.

To further address the gap of how and why water is used, research emphasises the importance of understanding water use through a practice approach rather than individuals' water consumption (Browne, 2015; Foden et al., 2017; Hoolohan and Browne, 2020). This is because water use between practices such as washing, showering, cooking and gardening can vary substantially within a single household. Research has illustrated that addressing the practice (rather than absolute water use in litres) can be a more effective and practical way of engaging with and reducing personal water consumption in the home. Therefore, not only understanding *how much* water is used, but also *why* and for *what purposes*, is important if water meters (and the information provided by meters) are introduced with the aim of reducing water consumption.

MAIN EVIDENCE GAPS

As part of this review, a number of key evidence gaps were identified. In relation to the effectiveness of water meters in reducing household water consumption, the evidence of actual water use following the installation of water meters remains relatively limited. Published evidence indicates that water meters can reduce water consumption, both through encouraging people to use less water but also through leakage detection. Only a few case studies of the absolute effects of metering on consumption exist. Measurements of water consumption patterns over longer periods of time, alongside regional and seasonal differences in consumption, are limited.

Further, published research available on the effects of metering rarely includes broader considerations and the potential unintended consequences that are important to take into account alongside meter installations. In order to address some of the key gaps in this area, four experts were interviewed to gain a better understanding of:

- What needs to be considered if water meters were to be introduced more broadly;
- The potential for broad-scale water metering to reduce household water consumption;
- The main unintended consequences from broad-scale water metering.

Expert interviews

Four experts from the University of Manchester and the University of Sheffield were interviewed. The experts, based in departments of Geography, Engineering and Planning, have expertise in water resource management, drinking water quality, water governance and public engagement.

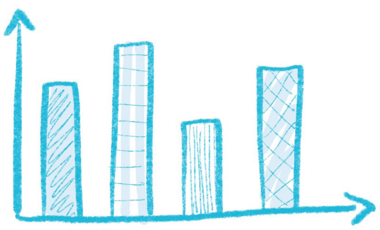
EFFECTIVENESS OF BROAD-SCALE METERING

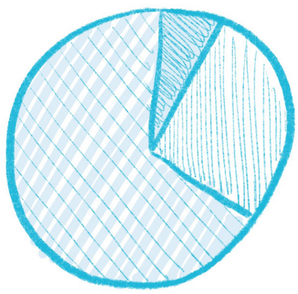
All interviewees agreed that installing water meters was a sensible thing to do, but that there should be realistic expectations of the extent to which the water meter, as a technical device, will achieve water consumption reductions, particularly in the long-term (interview 1, 2, 3, 4).

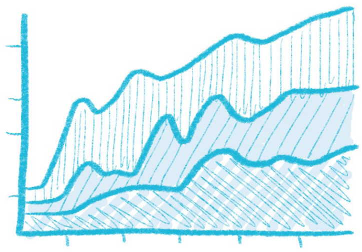
Interviewee 3 argued that water efficiency should focus on technical aspects (for example water efficient devices or leakage reductions) as a starting point, as these fixes could contribute to large water use reductions without having to rely on people changing their behaviours. For example, clear advice and incentives need to be provided to encourage people to change their appliances to more water-efficient options (interview 3).

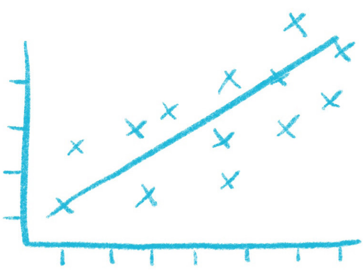
Across the interviews, there was consensus that the key benefit of installing smart water meters was the potential to detect leaks in the system, rather than the meter itself changing people's behaviour in relation to water use (interview 1, 2, 3, 4).

A second important advantage of smart water meters relates to the information they could provide, not only in terms of the amount of water used, but also how and for what purpose. This knowledge could then be used to underpin more targeted interventions to reduce water consumption (interview, 1, 2 and 3).









Before installing broad-scale water metering, it is important to consider what a meter is for (tracking water use, detecting leaks in the supply system or charging?) and what the most effective forms of metering for gathering the best quality data would be. Other key considerations include the scale at which that data would be collected (household, neighbourhood, region), who holds the data and what it is used for (interview 2)?

In relation to interventions identified alongside water meter installations, it was argued that the link between socio-demographic characteristics and actual water use is relatively weak and does not consider the full picture in terms of how and why water is used. There is a need to move away from socio-demographic categorisations as the main unit of analysis to gain a better understanding of household water use (interview 1).

A practice-based approach was suggested to be a more appropriate unit of analysis to better understand how and for what purpose water is used in the home. Changing the analysis from individual behaviours to social practices (and how these practices could be shifted towards more sustainable ones) was argued to be more effective for tackling water demand (interview 1,2). A standardised process, allowing for data to be collected every 3-5 years, that tracks a range of water practices and how these potentially change, could be used as a basis for considering how to prioritise further intervention (interview 1 and 2).

Further, it was argued that interventions such as water meters that encourage households to reduce their water consumption must not be limited to economic messages. There is a range of values underpinning why people may choose to save water and in order to connect people with water resource issues, framing water efficiency around the climate change emergency and community wellbeing could be more appropriate and effective (interview 3).

UNINTENDED CONSEQUENCES OF WATER METERING

Ensuring that water demand is reduced should be a priority, but efforts should not overburden vulnerable people. It is important to include analysis of a diverse set of vulnerabilities, beyond solely financial aspects, for example, in relation to health. Access to clean water needs to be recognised as a health-based right. It is therefore important to communicate that metering is primarily about detecting leaks in the context of maintaining future water supply (interview 1).

Similar arguments were raised by one interviewee who indicated that in communications related to water use there needs to be a much clearer distinction between water efficiency and wastage (for example leaky toilets). Water efficiency initiatives and associated communications must be designed without jeopardising people's health and well-being. The way to achieve water efficiency is to establish how to maintain health and well-being considerations, without wasting water (interview 3).

In order to minimise unintended consequences related to health, appropriate communication around water efficiency is crucial. Water meters and associated charging brings the risk of people becoming obsessive over saving water to save money, without recognising the public health risks, for example associated with not washing your hands. It could be argued that the installation of water meters does not have to be followed by meter charging. The benefits from the meter are primarily associated with detecting leaks, collecting data on water use and potentially feeding this information back to the user (interview 4).

In relation to health, the potential for reduced water consumption to lead to water stagnation within pipes and increased risks of drinking water contamination, for example from legionella and lead, were raised. There is also a potential health risk related to drinking water quality and water meters, if the supply system is not flushed properly after periods of stagnation in order to save water, particularly in households with lead pipes (interview 3).

Action points

To address the current evidence gaps related to the effectiveness of metering, and to maximise the opportunities for introducing broad-scale metering to reduce water consumption, policy design and evaluations need to:

- The seasonal variability in water use need to be considered to allow for interventions to be prioritised when they are most needed (e.g. during summer).
- Policy design and evaluations need to move beyond solely the economic benefits of saving water to consider the range of values and motivations that people attach to water savings.
- Future policy need to address the current evidence gap and include long-term evaluations of water consumption following policy interventions such as metering.
- Evidence suggest that socio-demographic characteristics are only weakly correlated with water use.
- Policy therefore need to be underpinned by innovative approaches that provide more effective ways of understanding *why* water is used, for example through a 'practice-based' approach (see Hoolohan et al., 2018 and Hoolohan and Browne, 2020; Foden et al., 2017). Such approaches are based on the assumption that people do not primarily use water in itself, but in order to perform everyday practices such as washing, cooking or gardening. Evaluating changes in practices following policy interventions provides a better understanding of water use in the home, particularly as water use across different practices can vary significantly within a single household.

To address possible unintended consequences of water efficiency measures, including metering, key action points are summarised below.

- Access to clean water needs to be recognised as a health-based right. Communications around water use need to more effectively separate water efficiency from water wastage (e.g. leaky toilets). Water efficiency measures and associated communication must be designed without jeopardising people's health and well-being.
- Interventions designed to reduce water consumption need to take a range of vulnerabilities into account. This means consideration not only of financial vulnerabilities, but also of health-related vulnerabilities.
- The introduction of broad-scale (smart) water metering does not necessarily need to be followed by meter charging. In this respect, it is recognised that the main benefits from broad-scale metering are to detect leaks and provide data on water use to underpin more targeted interventions. Evidence also highlights that there are other motivations beyond solely financial (for example environmental) that drive water savings. Meter charging

also raises issues about affordability as evidence shows that low-income, large households are financially worse off switching to meter charging.

- Interventions need to fully consider the potential impacts on drinking water quality (primarily increased concentrations of lead and risk of legionella), resulting from reduced flow velocity and greater water residence time in supply systems, following reductions in water consumption; and
- Water meter installations in households with lead pipes needs to consider the potential increase in lead concentrations in drinking water and effectively communicate these impacts to affected households. This is particularly true because the action to minimise the risk (flushing the supply system) might be in direct contradiction with the water efficient messages associated with the water meter installation.

Acknowledgements

The author would like to thank Jess Phoenix, Sharon Price and Heather Dowlman, Defra, Angela Wallis, Environment Agency and Laura Roberts, University of Sheffield for valuable input to previous drafts.

Citation text

Westling, E.L. 2021. Introducing broad-scale water metering: The current evidence base and key action points to reduce personal water use in England and Wales.
Author: Dr Emma Westling, the University of Sheffield.
DOI: 10.15131/shef.data.14494989

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emmacharleston.co.uk

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