TITLE: Do Water Meters Reduce Domestic Consumption?: a summary of available literature

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Abstract

At the present time 30% of UK households nationwide are on water meters and household consumption stands at approximately 150 litres/person/day (lpd), slightly more than Western European averages, but significantly less than North American or even Australian levels. Largely out of concern for the long-term effects of climate change on water supply, but also out of the notion that metering is "the fairest way to pay", the UK government is currently trying to build a consensus around the idea of legislating compulsory metering for the nation's 28 million households. However, there is much confusion as to the actual objectives to be served by such a policy, estimated to cost in excess of £3 billion. This paper presents the best available current research on water metering around the world, with a special emphasis on European, North American and Commonwealth comparator nations. In summary, the research suggests that there is little evidence that compulsory universal metering can achieve either the water conservation or social equity goals articulated by the government. The author concludes that policymakers need to think much more carefully about metering technologies and the purposes they are intended to serve.

Keywords: water, metering, policy, water industry

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1. Introduction

The UK government has signalled in recent years that it is considering legislating for universal water metering in England, Scotland and Wales. Echoing statements from other government ministers and senior civil servants over recent years –the received wisdom if you will -- former Climate Change Minister Phil Woolas said in 2008: "The case for universal metering is now overwhelming - provided there is protection for low income and large families." This viewpoint is echoed by OFWAT and the Environment Agency in numerous statements over recent years and perhaps most importantly by the Walker Review of Charging for Household Water and Sewerage Services which reported about this time last year (OFWAT, 2005; King, 2006; 2007; Walker Review, 2009). Many government officials contend that paying only for what you use (as measured by a meter) is both the fairest way to

pay and it also offers the potential for significant conservation savings, an important issue as the balance between water supply and water demand becomes more precarious. Both the Labour and Conservative Parties have been inconsistent in their attitudes to metering, generally opposing it whilst in opposition but favouring it when handed the reins of power (Drury, 2007; HC Debates, 1996 Dobson to Gummer). Currently (autumn 2010) the sector is preparing for a new Water White Paper, to be published in summer 2011, which we are promised will offer a "once in a generation" opportunity to restructure water services in England and Wales, with metering policy very much part of that mix (via a promise to take seriously the recommendations of Anna Walker and also those of Martin Cave on competition).

Since only about 30% of UK households are at present metered for domestic water use such a policy change would have significant impacts on UK households and the water sector in general. This paper summarises the research literature on water metering in the UK and around the world, directly citing more than 70 published studies from the more than 100 reviewed by Staddon and his research team. Given that the debate over meter implementation is often quite emotive and that there is much misinformation in public debate the focus here is on the objective scientific research with a view to separating fact from fancy and avoiding polemic. The author has no particular position on the issue of water metering although on balance he feels that the most often cited argument, that it can result in 15% demand reduction, does not stand up to scrutiny. For example, it is all too rarely observed that many of the countries with the highest meter penetration are also those with the highest consumption (e.g. Canada & the USA), whilst many of those with the lowest penetration have the lowest consumption (e.g. England) in world terms. Of course as the old statisticians' adage has it 'correlation is not causation', but it should be obvious that we need to tread very carefully when thinking about the possible linkages between water metering and water consumption –the crux of the current debate. The current enthusiasm in some quarters for metering as a "silver bullet" policy is, I am sorry to have to report, internally incoherent and poorly supported by empirical research – it is in my view the weakest of the proffered arguments for universal metering.

Ultimately, even die hard neoliberal resource economists must recognise that water is not "a commodity like any other", to paraphrase the 1992 Dublin Statement. Unlike luxuries such as mobile phone minutes, trips to Majorca or cheeseburgers we cannot ***not*** consume water services. This is one reason why I reject what I call the "petrol pump metaphor" in

discussions of water metering. A key theoretical finding of my research and thinking is that water is simply not just "a commodity like any other" and policymakers risk serious unintended consequences if they embark on initiatives predicated on that starting point.

The next section of the paper turns to the consideration of traditional (mainstream) perspectives on metering within the UK, including the well-known National Water Metering ("Isle of Wight") Trials begun in 1989. The third section of the paper turns to the experience of metering outside the UK, with special emphasis on other European, North American and Commonwealth countries. The fourth section explores further the conceptual and technical idea of a water meter, and in particular just what meters can and cannot do, with special reference to the "petrol pump metaphor". The paper concludes with some issue areas for further consideration with regards to water metering up to and including the need to reconsider the uses to which (different types of) water is being put in modern 21st century Britain. It is after all quite possible that what appears on the face of it to be quite "obvious"– the idea that metering is the only fair way to pay for water – turns out to be much less so once the multiple identities of water, the full costs of metering and related tariff reforms and the risk of unintended consequences are fully factored in. Similarly there are good reasons for doubting that metering can, *by itself*, deliver the claimed conservation benefits. The key conclusion of my analysis is that until the precise purposes of metering are clarified critical discussions of appropriate policy and technology cannot begin.

2. Traditional Approaches and Perspectives in the UK

Water metering trials have been undertaken in the UK and around the world over the past 30 years. Gadbury and Hall (1989) and others report on the establishment of the original UK metering trials of 53,000 households in the Isle of Wight, UK and in 11 other areas of the UK. The "National Water Metering Trials" ran from April 1989 to March 1993 and were set up to assess the practicalities of compulsory universal water metering (Smith and Rogers 1990; Gadbury 1989).[1] By 1993 the early results of this trial had shown that the average reduction in domestic consumption associated with compulsory metering seemed to be around 11%, though DEFRA (2006) claims savings of between 10 and 15% (and ministers have been known to claim as much as 20%). However the same trials also showed that as much as 40%

[1] Smith and Rogers (1990) report on the difficulties as of 1990 encountered in the Isle of Wight trial, including the higher-than-expected number of cases of multiple properties served by a single service pipe, high incidence of supply-pipe branching before an exterior wall was encountered and electrical earthing issues. Reporting on the Hotwells Trial (Bristol) Bessey (1989) similarly comments that the challenges posed by issues of single pipes serving multiple properties (apportionment) and electrical earthing were significant and unexpected.

of this apparent reduction was actually the product of better leak detection rather than reduced/disciplined household consumption. The trials also suggested that while compulsory metering appeared to have marked effects on *peak* demand with a 30% reductions in consumption recorded in peak monthly, weekly, daily and hourly demand (Dovey and Rogers, 1993), they had relatively little effect on *average* demand on either a per capita or annualised basis. Finally, there was evidence, even in this limited trial, that the conservation effects, such as they might have been, wore off after a short time, suggesting that consumers quickly become inured to the existence of the water meter under the kitchen sink (or in the road outside) and that any reductions in consumption could be equally well explained by the effects of the publicity surrounding the trials, weather conditions in the early 1990s or the early 1990s recession rather than the trials themselves. A study conducted earlier in 2010 by one of Staddon's students again showed, in this case for two localities in southwestern England, that the link between level of metering and level of consumption is complex to say the least (Rowe, 2010). In short, there are too many potentially confounding factors to be confident about the link between metering and consumption suggested by the National Trials. Similar studies undertaken in other parts of the UK since the National Trials, in Eastern and Southwestern England, have returned similar results – it is difficult to distinguish between the effects of better network knowledge and management, altered water consumption behaviours, prevalent economic conditions or weather and other extraneous local factors (e.g. condition of local housing stock, etc.). Thus, on the UK evidence, the true impact of metering needs to be seen in terms of better leak detection, reduced peak consumption and little difference in average consumption in exchange for higher cost and complexity in customer billing and management.

Assuming that current water metering technology could deliver, let's say for the sake of argument and personally I am doubtful about this, the 15% savings in average per capita use claimed by Ministers. That would equate to about 23 litres per person per day (lpd) (based on current individual UK consumption of 150 lpd) or 69 lpd for a 3 person household. For a model 3 person household this is equivalent to 25.2 m^3/year. With average water bills based on a volumetric charge of £2.20/m^3 in and out (supply and sewerage) the money savings could be estimated at about £55/year, not counting fixed standing charges, etc. However, to make this "savings" in water charges, the householder will have had to pay something like £300 for the initial meter installation and £40-50/year for operation and maintenance over the likely ten year life-span of contemporary meter technology, for an average financial burden of

perhaps £80/year. Taking a ten-year perspective (since current standard metering technology has a planned life of about ten years), the potentially-saved 252 m^3 will have "cost" the householder £3.20/m^3 (or 0.32 pence/litre) to save – *50% more than* current water prices. Another way of putting this is that it will have cost our householder £800 to save only £550 on their water bills over ten years – a net loss of £250! In terms of water savings, from the point of view of consumers this is simply not a rational trade-off.

Compare the above calculations with some alternative policies around water saving, summarised in Table 1 (SHOW). For example, sending each household in the land two Toilet Hippos, which cost about £1 each and can save in our hypothetical three person household, conservatively, about 4 cubic metres per year all by themselves, *in perpetuity*, at a marginal cost of £0.05 per cubic metre saved over the same ten year period. How about a more ambitious water saving proposal? – offering dual flush toilets to the perhaps 50% of households currently without them. Off the (B&Q) shelf dual flush (4.5/3 litre versus the 6 litre standard toilet) retrofit kits cost about £20 to purchase but could save as much as 1.5 litres per flush over "conventional" toilets, saving our hypothetical 3 person family 13 litres per day or 4.75 m3/year or £6/year off current bills – amortising the cost in only 3.3 years. Lest you think I have a toilet fetish, how about this one: replacing taps and shower heads with more water efficient ones could save our 3 person household 18.6 m^3/year or £22/year for a one-off investment of about £50 – amortisation time: 2.3 years. Table 1 presents these results in a more easily comparative format. Even on these simple calculations water meters turn out to be a relatively expensive way to save water – even allowing generous assumptions about water savings. And just in case you are wondering where these figures came from – mostly they came from the government's own report *Future Water: the government's water strategy for England*, published in February 2008.

Of course many studies have pointed out that metering may achieve little *by itself*, but rather needs to be considered *in tandem* with meaningful water tariff reform. Bohanna (1998) and Kay (1998) report on a trial of combined metering and tariff reform in Anglia in the 1990s. Both studies show that, with the right tariff structure, metering can achieve specified economic and environmental efficiency goals, particularly in terms of the management of peak demand. Edwards and Martin (1995) combined the data from the Anglian Water SODCON project (Survey of Domestic Consumption initiated in 1993 and continued to the present day) with a more rigorous study of the socio-economics of water usage utilising more

sophisticated water metering and data logging technology and social survey techniques.[2] This database is a rich source of information about water use patterns in a relatively water-stressed region and I take up some of the implications for social equity of a recent analysis of this data in later section of the paper. In the last few years there have been further limited experiments with seasonal and other graduated tariffs in England and Wales (e.g. South Staffs trials with a seasonal tariff differential of 50% in summer 2010, or £0.70/m^3 in winter versus £1.35/m^3 in summer – wastewater removal and standing charges remain unchanged meaning that the apparent effect on bills is likely to "feel" less significant)

As always analytical context is critical here – the sorts of results discussed above need to be seen in the context of available alternatives. Thus, it is worth asking how these metered patterns compare with trends in water usage in unmetered households? In line with standard industry practice, Anglian Water has had in place for a number of years a detailed household consumption monitor upon which the company bases its estimates of unmeasured household per capita consumption. It shows that, for Anglian Water at any rate, unmeasured household per capita consumption has actually *fallen* 2.4% since 1995-96, from 154 litres/person/day (lpd) to 150 lpd (Anglian Water, 2006). Similar findings are contained in many water companies' *Water Resources Management Plans*, published at the end of 2009.

There is currently much research underway, at Anglian and elsewhere, into the drivers of water use and this research has so far generally concluded that the conservation message is getting through and is having an independent effect irrespective of other measures that might be in place, and that improvements in the planning and building control systems may also be playing a part (e.g. Solley et al, 1995; Medd and Shove, 2005). In short, water metering is not the only way to approach the policy objective of driving per capita water consumption downwards. In addition to improvements to the planning and building control systems one wonders why greater use has not been made, until only this year, of more direct interventions in the marketplace including mandatory labelling of appliances for water efficiency as well as energy efficiency or indeed why water wasteful appliances are not simply removed from the marketplace where alternatives are available – as was recently done with lighting?

[2] From 2005 Anglian has discontinued the larger survey and retained only the ongoing survey of the 100 households comprising the original "golden 100" studied by Edwards and Martin (1995).

3. Studies Outside the UK

Outside of the metering issue has been widely discussed and examined around the world (ABS, 2006; OECD 1999; 2003; 2008). About two-thirds of OECD member countries already meter more than 90% of single-family houses, although *universal* metering remains a controversial issue everywhere. Selective, or what the OECD now calls "optimal", metering is less controversial, particularly if the public knows that water resources are increasingly scarce or if the metering only applies to discretionary water use, like private swimming pools. Metering *new* homes or on change of occupier is also more widely accepted than converting existing ones, perhaps because the issue of compulsion is experienced differently – householders are not 'forced' to get a meter, but merely find it increasingly impossible to move house without encountering one. Moreover, metering all new build also means that the cost of metering is part of the overall build cost and that it comes along with what is probably a more water –and energy – efficient home anyway – in this regard codes of sustainable homes have been quite helpful, though of course more could certainly be done. What follows is a brief survey of global experience.

Based on work in Argentina, Chambouleyron (2003) points out that without careful regulation of universal metering roll-out only sub-optimal results are likely to be obtained, both economically (for the customers and for the company) and environmentally (with respect to public policy intentions of reducing overall consumption, conserving water resources, etc.). He proposes that for metering to achieve these objectives a strong regulator is required to manage the transfer of rights to meter from consumer to provider, that the links between metering and tariffs must be clarified and that distinctions ought to be made between *Universal Metering*, *Optimal Metering*, and *Demand Metering*. The OECD report cited above too suggests that whilst Universal Metering may be non-economic and politically unpalatable, Optimal Metering (i.e. metering of key water users such as large buildings, buildings with pools, particularly water-scarce districts, etc.) may achieve markedly better results. In a subsequent paper (Chambouleyron, 2004) further argues that decisions about optimal types and numbers of meters can only be made conjointly with decisions about optimal tariffs. Until recently such subtleties have been largely absent from the debate about water metering in the UK.

Macleod (1979) reports on a study of Durban, South Africa in the 1970s which shows again that metering *alone* may not bring permanent conservation effects relative to not metering since consumers soon accustom themselves to the meters which themselves do

nothing to mitigate other upward pressures on water consumption (e.g. climate change, demand for water-using appliances and luxuries like hot tubs and pools or even power showers). This finding is in accord with the NWMT trials in UK reported above which showed that any apparent savings were "clawed back" over time. Since the end of Apartheid in the early 1990s water metering has, unfortunately, also acquired a racial dimension since the vast majority of meters have been installed in black townships where the "culture of non-payment" is seen as the problem to be solved rather than objective shortages of water resources (Pheko, 2007). Moreover there is a real danger that the recent renewal of sector interest in *pre-payment* meters could add a further racialised dimension to utility metering in that country – a realisation that recently drove Soweto residents to sue the City of Johannesburg over its programme for installing pre-paid water meters (Africa News, 2007; 2006). Whilst current UK law prohibits water companies from cutting off water supplies to non-payers, some within the sector still claim that pre-payment meters could get around this legal bar. In a separate paper Staddon, Appleby and Grant (forthcoming) discuss the complex relations between metering and rights to water in South Africa and elsewhere but for present purposes we need to be mindful of the likely social equity implications of any move towards pre-payment metering in the UK – it is already an issue in the electricity and gas sectors.

But what about more "extreme" cases; cases where the gap between supply and demand is more marked? A recent study in Abu Dhabi showed that in the "worst case" situation (where there exists both high water production costs and high water demand because of historic low fixed, non-metered pricing in a region of endemic water shortage) installation of meters could have a measurable conservation effect, especially if combined with more realistic (marginal cost) pricing of the (in this case largely desalinated) water. In Abu Dhabi Al Qdais and Al Nassay (2001) found that even in such extreme cases average price elasticity for water was very low (less than -0.1[3]) but highly variable – more well-off residents exhibited no demand elasticity whilst poorer residents showed alarming levels. Indeed the larger reductions in water consumption amongst poorer citizens risked public health problems. Similar results were obtained in a more recent study of universal water meter roll out in the cities of Chisnau and Orkhei, Moldova, a situation likely to be resolved only through further tariff reform and the return of cross-subsidies (Drozdov, 2002). Even the 2008 OECD report noted above found demand elasticity amongst the OECD countries studied to be between -0.1 and -0.5 –

[3] In other words, a 1% increase in price only brings about a 0.1% decrease in consumption.

with a likely reduction in demand elasticity as the 100 - 120 lpd consumption threshold was passed, presumably because below that level quality of life begins to be affected.

In Canada water services are provided mostly by municipal or regional public bodies ("crown corporations") sometimes subcontracting to private sector concessionaires. With the average Canadian consuming something like 300 lpd demand-side solutions have always been on the agenda (OECD, 2009). Since 1983 Environment Canada has managed a "Municipal Water Use Database" covering almost 1000 municipalities. Studies based on this data found that whilst consumption continues to decline slowly it is still well above 300 l/person/day.[4] Only the USA used more water - at 425 l/p/day on average. By 2001, 61% of Canadian residences served by municipal water systems were metered, up from 56% in 1999, 53% in 1996 and 51% in 1991. Driven on by recent warm spells some Canadian municipalities are again debating compulsory water metering as a way of reducing aggregate demand and generating "*nega*-litres" of "new" supply. Yet even Kamloops, British Columbia, a mid-sized city in the semi-arid interior of the province, recognises that other demand management strategies, such as public information campaigns, can be more cost effective in reducing demand. Recent experience of the Halifax Regional Water Commission (a publically-owned SWS company) shows that adoption of IWA/AWWA approved leakage detection and district-level water management systems can be more effective than universal metering in improving water efficiency (Yates, 2007).[5]

The experience of water metering as a mechanism for disciplining demand in the USA is, to date, mixed. In water-stressed parts of the US Southwest metering by itself has little proven long-term conservation effect and even where they are coupled with steeply rising block tariffs, the reductions achieved are modest – around 16% (Pint, 1999). Similarly econometric modelling of water bills from 383 American water authorities showed no discernable relation between metering, price and consumption variables except for those cases where *price information* was particularly highlighted on water bills and where prices were deemed to be non-trivial by consumers (Gaudin, 2006). Despite widespread concern about water resources, numerous initiatives to promote it, and indeed the much higher rate of domestic metering, average water consumption in the USA remains near 400 litres/person/day – *almost three times UK consumption*. Even in much of the desert southwest. Contra the

[4] OECD figures often depict Canadian water consumption somewhat differently, showing that average per capita water abstractions run at about 1400 m^3/year. This figure is of course inclusive of all water uses, including the large and relatively inefficient agricultural sector and should not be taken as an index of direct domestic consumption which is running at 300 l/p/day or about 110 m^3/year.

[5] Supplies 325,000 people in the Halifax, Nova Scotia municipal region through a 1300 km pipe network.

expectations of metering advocates, it has proven the case that cities that have achieved significant reductions in consumption have often done so through public education, bill redesign and infrastructure improvements (particularly with respect to leakage), such as Boston's 20 year leak reduction programme which has obviated the need for significant new supply development and the programme in Halifax, Nova Scotia noted above (Postel 2005). And even simple "tweaks" such as altering bill format to highlight costs and/or consumption can have a measurably greater effect than meters alone.

4. Water Meters as 'Socio-technical" Interventions…and the "petrol pump metaphor"

The vast majority of contemporary water meters are simple mechanical devices which register the passage of water past a mechanical impeller whose spin is calibrated into cubic litres of consumption. More than a decade ago Cascetta (1994) and Sanderson (1994) showed that ultrasonic and other "non-wetted" technologies can provide accurate and reliable results, thereby getting past difficulties such as the inevitable wearing out and loss of accuracy of mechanical device. Similarly Windgassen (2006) points out that electromagnetic flow meters can provide long-life, low maintenance and no need to install filters and strainers. Such devices can be linked to more or less sophisticated data logging and communications systems. Severn Trent is currently trialling the use of such "smart" meter designs in their region as well as marketing their 'SN150 S1.5' type meter Europe-wide. Elsewhere in the UK, rollouts are now underway of comprehensive (gas & electricity, but not yet water) smart metering technology designed to:

- be remotely read and to be linked to variable tariffs
- be easily read locally, and therefore meaningful to consumers
- be linked to internet databases rather like EBay or bank accounts

Evidence from abroad suggests that such meters can effect a significant reduction in consumption of gas and electricity……..but not for water services. And these new generation meters are much more expensive than "traditional" mechanical alternatives. Severn Trent Services has been trialling smart meters in 800 Midlands households, but so far the big findings are not about reduced consumption, but higher levels of leakage detection than expected, particularly in customers' own supply pipes – a fact that has significant cost implications for both customers and water companies. According to an STS Engineer "Customer pipes are often elderly and as one leak is fixed another pops up…there could be a backlash against metering as the scale of supply pipe leakage is realised." Will universal

water metering therefore bring in its train a call for wholesale supply pipe adoption – who wants to field that little hand grenade in these economic times?

Simon Marvin and his colleagues at Salford University (1999) argue that metering is much more than a technical issue to be assessed with reference to single variables such as 'maintenance costs' or 'efficiency savings'. Instead they argue that "smart" water meters (which can of course do much more than merely measure consumption) can be understood as part of what they call "technical development pathways" (TDPs) that restructure (often radically) the relations between water providers and water consumers (shades of Cambouleyron's South American study here). Subsequently they identify four distinct TDPs that can, on their view, re-embed environmental and social justice outcomes at the heart of new smart water metering and pricing systems in the UK. Though Marvin et al (1999) identify more than 50 distinct kinds of utility meter, they resolve this multiplexity into combinations of three different kinds of issue:

- exactly what variable(s) the meter measures and, increasingly, controls
- how the meter communicates with water managers, regulatory authorities and consumers
- the relations between the information gathered and attempts to influence usage

Thus it is now technically possible (disregarding cost or complexity for a moment) to configure metering systems that restrict or expand flow at times of critical loading or excess capacity in the system or, as in various smart metering trials around the UK and Europe, provide time-linked consumption data to support more sophisticated variable tariff structures. So new "smart" metering technologies can act as *regulators* as well as assessors of utility supply.

Marvin et al. (1999) further argue that, ultimately, optimal outcomes can only be achieved with "user-driven" smart metering systems which direct information about consumption trends, tariffs and conservation options through a user-viewable and programmable console in the home. A trial of one such system (for electricity) only, in Bath, UK showed that it is technically possible to make consumption more "visible" to consumers themselves, a key problem with current mass metering standards in all utilities. In addition to smart meters installed by power utilities themselves consumer side devices like the OWL monitor allow consumers to get a better handle on the drivers of their particular electricity consumption profiles. Yet such trials are in their infancy in the water sector, and again I would point out that a significant portion of our current 150 lpd is likely to be personally and socially necessary. Marvin et al (1999, p.122) worry that:

> Environmental applications are, however, currently being `squeezed-out' of smart-metering configurations. Utilities are [often] more interested in implementing those applications they consider most appropriate in the context of the commercial priorities set by privatisation and liberalisation.

As noted above currently there are limited trials with "smart" water meters although some companies, such as Severn Trent are already installing electronically readable meters that are (at least) capable of smart functions (CCW 2006). Robson and Howsom (2006) provide a brief overview of metering issues in the UK since privatisation, suggesting that government must provide proactive leadership if any sort of metering (for environmental or equity outcomes) is to be implemented to any great degree – will this be forthcoming in 2011's Water White Paper? So far much "smart" metering in the utilities sector has involved the development of "prepayment" meters in the gas and electric sectors. Trials in the water sector were underway prior to the passage of the *Water Act 2003* which banned the shut-off of water services for any reason – though some in the sector had tried to argue that "self-termination" through non-prepayment was technically not a "shut-off" of services (van der Merwe, 2003).

These are some of the reasons why I said at the outset that I reject the "petrol pump metaphor" that seems to underlie some arguments for universal water metering. Another is that water simply is not, to turn on their head the 1992 Dublin Principles, "a commodity like any other". Unlike mobile phone minutes, weekend breaks to Barcelona or cheeseburgers we cannot ***not*** consume water services. While we can certainly choose to forgo that iphone upgrade that costs £30/month or that car trip to Alton Towers, a considerable amount of our daily 150 lpd is actually NOT discretionary. The WHO, UNHCR and other organisations suggest perhaps as much as 50 lpd represents a good target for water provision in even developing world or refugee contexts. Although this target is quite often not met in developing nations or refugee contexts (e.g. in the recent Mpiri Case the South African Constitutional Court decided that 25 litres was a more appropriate benchmark for that country), the UK's 150 lpd is already much closer to that minimum than it is to the superleague of the world's real water wasters – for example the US and Canada. And with water poverty now a fact of British life, I would urge that we need to think very carefully about how a universal metering drive might create unintended consequences for social equity and even public health (*anecdote – nits in public schools in England*).

5. Public Attitudes to Metering

While public attitudes towards water metering do seem to be changing if recent research is anything to go by, it appears that official attitudes are changing more rapidly and drastically than public ones. Water is a necessity in life not only for drinking but also for hygiene, and therefore it is unsurprising that, notwithstanding OFWAT's claims above, many consumers feel that water should not have to be metered, or even charged for, at all (Buller, 1996; Corr Willbourn, 2007; Gleick et al, 2002; Lobina and Hall, 2000). Water, for many Britons, is still seen as a public service. However in government circles this is beginning to change as the government brings in new laws, such as the *Environmental Act 1995*, the *Water Industry Act 1999, the Water Act 2003*, and companies such as Folkestone and Dover Water are allowed to enforce compulsory water metering. Moreover, at the moment people tend to think about water and water scarcity in terms of the world 'out there' as if it is somehow detached from them (Medd and Shove 2006). Put another way, climate change is now widely accepted, and people are well aware that it may be imposing absolute limits on other parts of globe (e.g. Africa), but they seem more likely to see shortages in the UK as the product of regulatory incompetence, corporate cupidity or collective rather than individual action (Opinion Leader Research, 2006). So before water metering becomes 'normal' in society consumers will need to understand *their part* in the overall water balance, and how it can have significant aggregate effects on total demand, particularly at peak times. This will be especially true for those for whom metering results, at least initially, in higher bills (implying of course that they have been heretofore enjoying a hidden subsidy). And let's be clear – that MUST be what we are ultimately saying – the metered-unmetered differential is going to have to be abandoned at some point, and at that point will we move away from "RPI + X" water pricing also?

And what about sanitation? Most considerations of water metering seem to take in only drinking water – yet fully a third of domestic water use comes from toilets, which bespeaks not just the water-inefficient removal of bodily waste materials but in fact all sorts of domestic waste materials from sanitary products to cooking oil – we know that FOG is one of the biggest challenges facing those who maintain our sewerage network. Could it not be argued that much of the 100 or so lpd above and beyond the WHO mandated minimum of around 50 lpd is necessary for the efficient functioning of our sewerage system? Data from apparently low water consumption countries such as the Czech Republic and Germany suggests that actual consumption may not be so low if one takes account of the energy and water costs of more frequent pigging of their sewerage networks.

In most recent research that has touched on water metering and tariff reforms there is an under-noticed finding. Though initially attracted to the ideas of paying only for what you use and avoiding cross subsidies, British consumers are also quite fair-minded and socially conscious. Deliberative research into willingness to pay leading up to the PR09 settlements shows that once the complexity of water pricing is fully explained most British consumers soften in their attitudes to water pricing, metering and cross-subsidies. Yet there is another face to this research finding – whilst British consumers still accept to quite a high degree the notion that water is a public good their attitude towards the privatised sector can be quite different. On the one hand most consumers are prepared to pay extra so that the less fortunate don't go without and the environment is protected, on the other hand they also believe that the private companies should provide them with whatever they want, an indeed they can be quite intolerant of even minor interruptions in supply. As Chappells (2005) points out, this is merely reaping one of the indirect implications of the increasingly marketised UK water system: the growing perception that water can be used for whatever consumers are willing to pay for. This sits uneasily with the residual perspective on water as a public good or commons (Bakker, 2001). Perhaps we need to think in more nuanced ways about water's many uses and identities – as source of rehydration, as part of cooking, hygiene, waste removal, etc. Do we need different approaches for each of these such that we recognise the difference between demand inelastic uses and those which might be more discretionary…..this brings us back to the issue of rising block tariffs and the like or to dual water supply – which is all the rage in parts of Asia, but would probably be ruinously expensive here.

6. Conclusions

(1) part of the call for universal water metering in England and Wales is based on the idea that meters will effect the same suppression of excess water consumption that they appear to exercise on petrol or electricity consumption (what I called above the "petrol pump analogy"). However, since we have long had universal metering in electricity and petrol (albeit operating in different ways), there is little reliable evidence that the metered households actually are more conservative of electricity or petrol than non-metered houses – because there aren't any such houses! The analogy is therefore quite problematic. Moreover around the world the data on water metering is ambiguous to say the least: some of the most thoroughly metered

regions in the world are also amongst the most profligate. And neither do low levels of metering mean high levels of consumption of water, electricity, etc.

(2) There seems to be relatively little critical discussion of the optimal location for water meters or the optimal technology to deploy. It is interesting that whilst some proponents declaim on the need for meters it is simply assumed that these should be located at the service inlet to *each and every house* in the land. Yet it is already the case that UK water companies operate "district metering" and "consumer panels" methodologies which give them an accurate insight, in the absence of any further metering, into household-scale consumption patterns.[6] Companies already know, to a fairly high degree of accuracy, how much water we use. And customers are actively encouraged to move over to cheaper tariffs in appropriate circumstances, for example single occupier tariffs. What then would a move towards 100% domestic water metering actually bring with it that we don't already have?

(3) one answer is that more domestic metering would bring better knowledge about exactly where water is leaking from the distribution network – we know that it is something like 15 to 20% system-wide, but we often don't know where until we see geysers in the streets. But to the extent that reducing leakage is a public benefit one wonders if it should be paid for publically, the same way parks and environmental amenities are paid. To the extent that it is a company benefit, then surely the company should pay – and not merely pass the cost on to the consumer through the price review mechanism since better leak detection will help provide the supply for new domestic and commercial developments in the future?

(4) Questions about metering are intrinsically linked to questions about pricing; therefore, discussions about metering need to be "joined up" with discussions about tariffs. What sorts of tariffs can yield more promising demand elasticity than current appears to exist? If we begin to seriously experiment with rising block and other tariff types, might we be in danger of moving towards alternatives that are more costly than is justified?

(5) And what will it cost to ensure that such demand elasticity does not adversely affect the less well off? We are already seeing the emergence, in the current recession, of "water poverty" as a reality of British society. And water poverty is, along with fuel, food and shelter deficits a very damaging thing in a society that cares for the less well off – a certain

[6] For example since 1985 Severn Trent Water PLC has used the "Domestic Consumption Monitor" method developed in conjunction with UK Water Industry Research. A stratified random sample of 1000 unmetered domestic customers have been fitted with meters and data loggers to provide the company with detailed data about spatial and temporal variations in consumption.

level of water consumption is obligatory, not just for personal health, but for public health – we cannot not use water!

(6) given that there appear to be many as yet unrealised "no tears no regrets" options for securing greater water conservation, including alteration of planning and building control regulations, removing water-wasteful appliances from the marketplace when there are more efficient alternatives and allowing the natural increase in water metering to come with future building cycles surely a stronger case needs to be made for such a costly roll-out NOW.

In conclusion universal water metering can be deployed for a number of purposes including (but not limited to) disciplining consumption, so it is therefore very important that policy-makers are very clear about what metering is intended to do. Is it intended to reap that mythical 10 to 15% reduction in consumption often talked up by Ministers? Is it intended to clearly ties what one pays to consumption? Is it meant to improve knowledge of the distribution network, especially leakage? As Marvin et al (1999) point out "…the precise technical configuration of the meter is strongly shaped by the often conflicting objectives of agencies involved in developing and implementing the systems. The way in which these different groups envisage the social organisation of relations between the utility and the household, and their relative strength in influencing metering developments frame the systems which emerge." In the UK case it is clear to see that whilst existing stakeholders all talk about metering, their perceptions of and expectations for them are divergent. Thus it is incumbent upon regulatory authorities to create a strong, well-supported and *unified* voice for smart metering options which can achieve environmental and social equity goals. Moreover the argument about the purported fairness of water meters is widely recognised as just another version of the argument for "user fees" which, in extremis, erodes the social basis of modern political society and may represent yet another form of "governmentalisation by stealth" of daily life (Bakker 2001; 2005; Jenkins, 2006).

Words: 6500

7. References

Africa News, (2007) Nigeria: Water Supply - Govt to Introduce Pre-Paid Meter, *Africa News*, October 12, 2007.

-------- (2007) South Africa: Flood of Anger Over Jo'burg Water Plan, *Africa News*, May 10, 2007

-------- (2006) South Africa: Water for All?, *Africa News*, December 22, 2006.

Alcamo, J., Dronin, N., Endejan, M., Golubev, G. and Kirilenko, A, (2007) A new assessment of climate change impacts on food production shortfalls and water availability in Russia, *Global Environmental Change*, In Press, Corrected Proof.

Author Unknown, (2007) Meter Consensus Out of Reach, *Kamloops Daily News*, October 23, 2007, Pg. A6

BBC News, (2006) Homes forced to get water meters, [on-line] BBC News, UK, http://news.bbc.co.uk/1/hi/england/4759960.stm Accessed 15th November 2006

2006 "Bringing meters out of the closet", by Mark Kinver, May 18, 2006

Bakker, K. (2005) Neoliberalizing nature? market environmentalism in water supply in England and Wales, *Ann.Assoc.Am.Geogr.*, 95(3), 542-565

-------- (2001) Paying for Water: water pricing and equity in England and Wales, *Transactions, Institute of British Geographers*, NS 26, 143-164.

Bessey, S.G. (1989) Problems Encountered in the Hotwells District Small-Scale Metering Trial, *Water and Environment Journal*, 3(6), 579-582

Bohanna, D. (1998) Water meters: an incentive to conserve and a signal to the market. *Economic Affairs*, 18(2), 10-13.

Buller, Henry (1996) Privatization and Europeanization: The Changing Context of Water Supply in Britain and France, *Journal of Environmental Planning and Management* 39(4) 461

Butler, D. and Memon, F.A. (2006) *Water Demand Management*. IWA Publishing.

Butler, E. and Boyfield, K. (2002) *Around the world in 80 ideas 28:The right stuff, user rights and water conservation*, [on-line] Adam Smith Institute, UK. http://www.adamsmith.org/80ideas/idea/28.htm, Accessed 14th November 2006

Cascetta, F. (1994) Application of a portable clamp-on ultrasonic flowmeter in the water industry. *Flow Measurement and Instrumentation*, 5(3), 191-194.

Chambouleyroun, A. (2004) Optimal water metering and pricing. *Water Resources Management*, 18(4), 305-319.

Chambouleyroun, A. (2003) An incentive mechanism for decentralized water metering decisions. *Water Resources Management*, 17(2), 89-111.

Consumer Council for Water-Midlands, (2006) "Policy on Domestic Metering", draft discussion document.

Corr Willbourn Research and Development, (2007) "Deliberative Research into Consumer Views on Fair Charging for the Consumer Council for Water", A Commissioned Research Report, www.corrwillbourn.com

Darrel Jenerette, G. and Larsen, L. (2006) A global perspective on changing sustainable urban water supplies. *Global and Planetary Change*, 50(3-4), 202-211.

DEFRA, (2006) *Water saving group*, [on-line] Defra, UK. http://www.defra.gov.uk/environment/water/conserve/wsg/pdf/wsg-meteringpaper.pdf, Accessed 14th November 2006

-------- (2006) *Elliot Morley urges action on wasted water*,Defra, UK. http://www.defra.gov.uk/news/2006/060308c.htm, Accessed 14th November 2006

-------- (2006) *Delivering a sustainable water supply; government gives company wider powers to meter*, [on-line] Defra, UK. http://www.defra.gov.uk/news/2006/060301c.htm, Accessed 14th November 2006

-------- (2000) *Water metering your new rights*, [on-line] Defra, UK. http://www.defra.gov.uk/environment/water/industry/water_metering/rights.htm, Accessed 13th November 2006

Dovey, W.J., Rogers, D.V. (1993) The Effect of Leakage Control and Domestic Metering on Water Consumption in the Isle of Wight", *Water and Environment Journal*, 7(2), 156-160

Drozdov, S. (2002) Use of Water Consumption Metering as a Tariff Policy Tool: Moldova's Experience"

Drury, I. (2007) Meters could add £200 to the family water bill", *Daily Mail*, October 15, 2007

Edwards, K. Martin, L. (1995) "A Methodology for Surveying Domestic Water Consumption" *Water and Environment Journal*, 9(5), 477-488

Foster, H. Beattie, B. (1979. "Urban Residential Demand for Water in the United States", *Land Economics* 55(1), 43-58.

Gadbury, D. Hall, M.J. (1989) Metering trials for water supply. *Journal - Institution of Water & Environmental Management*, 3(2), 182-187.

Gaudin, S. (2006) "Effect of price information on residential water demand", *Applied Economics*, #38, 383–393

Gleick, P.H. Wolff, Chalecki G. Reyes E.L. (2002) *The New Economy of Water: The Risks and Benefits of Globalization and Privatization of Fresh Water*, Pacific Institute for Studies in Development, Environment, Security

Guy, S., Marvin, S., Moss, T. (2001) *Urban Infrastructure in Transition*, London: Earthscan

Hall, M.J., Hooper, B.D. and Postle, S.M. (1988) Domestic per capita water consumption in South West England. *Journal - Institution of Water & Environmental Management*, 2(6), 626-631.

Hobson, S. (2007) Water Leak figures trump estimates, *Utility Week*, October 19, 2007

Jenkins, J.O. (2006) Water Metering: in search of a more critical debate, unpublished paper, CCW-Thames Region.

Kay, S.B. (1998) Metering for demand management: The Cambridge experience. *Journal of the Chartered Institution of Water and Environmental Management*, 12(1), 1-5.

King, D. (2007) A measure of change, *Utility Week*, October 26, 2007

King, D. (2006) Managing Water Resources in England and Wales, a lecture by David King, Director of Water Resources, Environment Agency, June 6, 2006 at the Foundation for Science and Technology, London, UK.

Lobina, D., Hall, D. (2000) Public Sector Alternatives to Water Supply and Sewerage Privatization: Case Studies, *International Journal of Water Resources Development*, Vol. 16 Issue 1, 35-56

Lund, J.R. (1988) Metering utility services: evaluation and maintenance. *Water Resources Research*, 24(6), 802-816.

MacLeod, (1979) The effect of metering on urban water consumption (Durban, South Africa). *Municipal Engineer (Johannesburg),* 10(3), 23-26.

Martin, W.E., Ingram H.M.; Laney N.K.; Griffin A.H. (1984) *Saving Water in a Desert City* Washington, DC: Resources for the Future.

Marvin, S., Chappells H., Guy S. (1999) Pathways of smart metering development: shaping environmental innovation. *Computers, Environment and Urban Systems,* 23(2), 109-126.

Medd, W. and Shove, E. (2006) *Traces of water workshop report 5; Imagining the future,* [on-line] Lancaster University, UK. http://www.lec.lancs.ac.uk/cswm/download.TWW5_Report.pdf, Accessed 20th November 2006

Medd, W. and Shove, E. (2006) *Traces of water workshop report 4; Water stresses and the consumer,* [on-line] Lancaster University, UK. http://www.lec.lancs.ac.uk/cswm/download/TWW4_Report.pdf, Accessed 20th November 2006

Medd, W. and Shove, E. (2005) *Traces of water workshop report 2; Water practices in everyday life,* [on-line] Lancaster University, UK, http://www.lec.lancs.ac.uk/cswm/download/tww2_report1.pdf, Accessed 20th November 2006

Medd, W. and Shove, E. (2005) *Traces of water workshop report 1; Perspectives on the water consumer*, [on-line] Lancaster University, UK. http://www.lec.lancs.ac.uk/cswm/download/tww1_report1.pdf, Accessed 20th November 2006

Mercer, D., Christensen, L. and Buxton, M. (2007) Squandering the future—Climate change, policy failure and the water crisis in Australia. *Futures,* 39(2-3), 272-287.

Merritt, W.S., Alila, Y., Barton, M., Taylor, B., Cohen, S., and Neilsen, D. (2006) Hydrologic response to scenarios of climate change in sub watersheds of the Okanagan basin, British Columbia. *Journal of Hydrology,* 326(1-4), 79-108.

National Water Metering Trails Working Group, (1993) *National Metering Trials Final Report*, Water Services Association.

OECD, (1999) *The Price of Water: Trends in OECD Countries*. OECD: Paris.

OECD, (2003) *Social Issues in the Provision and Pricing of Water Services*. OECD: Paris.

Opinion Leader Research, (2006) Using Water Wisely: a deliberative consultation", research conducted for the Consumer Council for Water, UK.

Perkins, P. (2007) Solving Canberra's Water Woes", *Canberra Times*, October 26, 2007

Pheko, M. (2007) Policies perpetuate the invisible racism rampant in our country" *Sunday Times* (South Africa), October 14, 2007

Pint, E.M. (1999) Household Responses to Increased Water Rates During the California Drought", *Land Economics*, 75(2), 246-266

Postel, S. (2005) From the headwaters to the sea: the critical need to protect freshwater ecosystems" *Environment*, 47(10), 8-22

Robson, A. and Howsam, P. (2006) Domestic water metering - Is the law adequate? *Journal of Water Law*, 17(2), pp. 65-70.

Severn Trent Water PLC, (2006) Customer Priorities and Willingness to Pay", final report on research conducted for Severn Trent by Accent, London, UK.

Sanderson, M.L. (1994) Domestic water metering technology. *Flow Measurement and Instrumentation*, 5(2), 107-113.

Shove, E. (2003) *Comfort, Cleanliness and Convenience: the social organization of normality*. Oxford, Berg.

Smith, A.L. and Rogers, D.V. (1990) Isle of Wight water metering trial. *Journal - Institution of Water & Environmental Management*, 4(5), 403-409.

Solley, W.B., Pierce, R.B., & Perlman, H.A. (1998) *Estimated Use of Water in the United States in 1995*, U.S. Department of the Interior. US Geological Society. Denver, CO: USGS.

Staddon C, Appleby T, Grant E, forthcoming

Thomas, A and Millard, A, (1994) Budget metering in the water sector. *Flow Measurement and Instrumentation*, 5(2), 143-143.

van der Merwe, L.H. (2003) Metering in demand: Uncovering prepayment. *Water Sewage and Effluent*, 23(5), 30-33.

Van Vliet, B., Chappells, H., Shove, E. (2005) *Infrastructures of Consumption: Environmental Innovation in the Utility Industries*. London, Earthscan.

Watts Committee, (1985) *Joint Study of Water Metering - Report of the Steering Group*. HM. Stationary Office. London

Windgassen, H. (2006) Municipal water metering - the electromagnetic solution. *World Pumps*, 2006(483), 26-29.

Yates, C. (2007) Metered districts, software, help stem water leakage", *Water World*, 23(10), 24-26.

Words: 5100

Water Saving Measure	**Ten year cost of measure (GBP)**	**Potential Savings in m^3**	**Cost per cubic metre saved (GBP)**	**Pay back period (years)**
Water Meters	800*	252	3.20	never
Toilet Hippos	2	40	0.05	0.25
Dual Flush Retrofit	20	48	0.42	3.3
Tap/Shower head Retrofit	50	186	0.27	2.3

Table 1 (note that the current average cost for water services is about £2.20/m3 of water supply and sewerage, with about £40/year added for standing charges and surface water drainage)

*unlike the other costs, this cost is recurrent on a roughly ten year cycle, unless new water meter technologies with longer working lives replace existing impeller-types.