SES WATER

APPENDIX SES051

COST BENEFIT ANALYSIS SMART METERING

Report: Cost benefit analysis of water smart metering

Produced by Frontier Economics and Artesia, supported by Arqiva

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Contents

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Executive Summary

Frontier Economics and Artesia have been commissioned by Arqiva to evaluate the benefits and costs of a smart metering programme for the water sector across England & Wales. This report explores the balance of costs and benefits at the national level, as well as for individual water companies and regions. For the purposes of this analysis, we define smart meters to be Advanced Metering Infrastructure (AMI). This is distinct from Automated Meter Reading (AMR), which includes data loggers, and dumb meters that require a physical meter read.

Water smart metering (WSM) can provide a range of benefits to water companies, households and society.

- Benefits flow from the reduction in water usage as smart metering encourages households to reduce consumption, and also identifies and reduces customer-side leakage. Lower water usage reduces water companies' operating and capital costs on future water resource schemes.
- WSM also benefits water company operations. It results in lower meter reading costs, improved demand forecasting and providing better data to manage the infrastructure.
- Benefits for households include better customer engagement, accurate bills and lower bills where the net benefits are positive.
- Benefits for society include a reduction in water consumption (reducing stress on local water environments) and an associated reduction in carbon emissions.

WSM is increasingly being recognised as the next logical step in household customer meter roll-out, building on the current dumb and AMR metering programmes. To understand the cost-benefit case, we have modelled scenarios for WSM roll-out, comparing the outcomes to a base case that continues the current metering policies. Our modelling results are therefore incremental to the 'business as usual' plan for metering.

Main findings

Compared to current metering plans, our modelling shows that a co-ordinated roll-out of WSM in the period 2025 to 2030 would deliver benefits of £4.4 billion compared to costs of £2.5 billion. Therefore it achieves net benefits of close to £1.9 billion and there is £1.73 of benefit for every £1 of cost incurred.

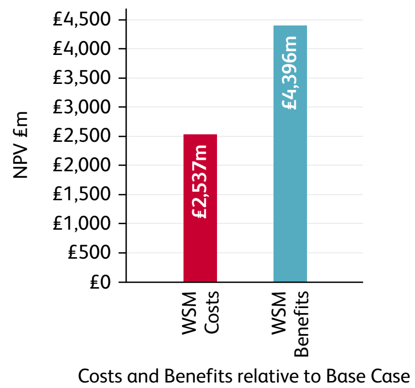

Figure 1: Costs and benefits of WSM roll-out across England & Wales. Source: Frontier / Artesia.

In addition, the modelling analysis shows that WSM will be beneficial in every region and for every water company in England & Wales. The benefit-to-cost ratio varies across the country depending on existing meter penetration and the extent of water scarcity.

A major element of the case for WSM revolves around benefits for society in the form of reduced carbon emissions. Nevertheless, just focussing on the costs incurred by the water companies there is a positive investment case for WSM. The expenditure on WSM is more than offset by cost savings on leakage control, network management and avoided costs of other water resources. The WSM programme will cost £2,537 million (NPV over 30 years) but will result in offsetting cost savings for water companies of £3,263 million. This net cost saving of £726 million will result in lower average bills for households.

The above results relate to a WSM scenario which assumes that households are automatically transferred onto a metered charging basis. This scenario delivers the greatest benefits because areas where more customers are billed on a metered basis will, on average, have lower consumption. However, water companies may prefer to give their customers the option to stay on a unmetered charge should they wish to do so. Therefore we have also modelled a scenario where households retain the choice of metered or unmetered charging basis.

The optional charging scenario does reduce the net benefits compared to the compulsory charging scenario but the impact is not great. The BCR falls from £1.73 of benefit for every £1 of cost to £1.70 of benefit for every £1. There is still a strong cost-benefit case in this scenario.

Defra's draft Strategic Policy Statement for Ofwat states that "water companies must act to reduce demand for water in a way that represents best value for money in the long-term". This report demonstrates that smart metering does provide a cost-beneficial way of reducing demand, and will both enable the reduction of customer supply pipes and help reduce personal water consumption.

1.0 Introduction

Frontier Economics and Artesia have been commissioned by Arqiva to evaluate the benefits and costs of a smart metering programme for the water sector across England & Wales. This explores the balance of costs and benefits at the national level, as well as to individual water companies and regions. For the purposes of this analysis, we define smart meters to be Advanced Metering Infrastructure (AMI). This is distinct from Automated Meter Reading (AMR), which includes data loggers, and dumb meters that require a physical meter read.

This paper assesses the costs and benefits of a co-ordinated roll-out of water smart metering across England & Wales.

This report sets out:

- The scope of the work, including our methodology, framework and the limitations of this analysis.
- The benefits of smart metering, including how smart metering can help meet challenges facing the sector and the details benefits and costs included in our modelling.
- The positive social case for WSM roll-out across England & Wales based on our CBA modelling.
- The CBA results by water company and region and the investment case for water companies.
- The policy implications of our analysis.

2.0 Scope of the work

In this Section we set out:

- The definition of smart metering we use and the details of Arqiva's smart metering technology;
- Our Cost-Benefit Analysis (CBA) methodology;
- The framework for assessing costs and benefits;
- Our scenario based approach to the modelling;
- Our core model specification; and
- The limitations of the modelling.

In the following Section we provide more details on the overall benefits of smart metering and the details of the benefits and costs included in our modelling.

2.1 Defining smart meters

For the purposes of this analysis, we define smart meters to be Advanced Metering Infrastructure (AMI) where hourly meter data is transmitted daily via a fixed network to the utility. This is distinct from less sophisticated metering technology such as mechanical meters that require a physical meter read and Automated Meter Reading (AMR).

2.1.1 Arqiva / Sensus fixed network technology

The water smarter meters (WSM) meters in this report are assumed to be Sensus meters connected to an Arqiva radio fixed network. The key features of this method for smart metering are as follows:

This model is an end-to-end managed service which includes the supply of water meters, end points and tools for the water company or their contractors to install. The end points communicate between the smart meter in the bottom of the meter pit and a radio network base station.

Arqiva provides the radio coverage based on their existing site portfolio, with additional base stations providing the link between the end points and the existing radio network.

Data collected at the base station is relayed securely to Arqiva-owned and operated data centres. From this point the data is passed on securely to the water company meter data management system, to use the data for billing, for providing data to customers and for analysis. The system can provide hourly or 15-minute data, 24 hours per day, 7 days a week.

Arqiva provides this service based on a price per meter per year, depending on the length of the contract and the number of meters deployed. The price per meter covers the warranted life of the meter, so includes for the replacement of faulty meters.

2.2 Our CBA methodology

Our overall modelling approach builds on the previous work on smart metering published by UKWIR in 2012[1]. This approach identifies values for a range of costs and benefits associated with smart meters and converts these into values per household, based on the meter type (smart, dumb or AMR).

We have created two WSM scenarios, recognising that there are multiple pathways to a smart meter future. These consider what the existing costs and benefits under a business as usual approach to metering are, and then compares these with a scenario for progressive optant meters and progressive compulsory meters.

The analysis reflects best practice in evaluation and is consistent with HM Treasury Green Book methods for evaluation. We use a 30 year time horizon to capture that the benefits will last over a period of time and we use The Green Book social discount rate to estimate the net present value (NPV). The Arqiva / Sensus contract costs are annual costs, which have been discounted over time consistent with Green Book guidance.

The data for this analysis from public sources including Ofwat submissions with WRMI tables and water company draft WRMP tables. Data on costs of smart meter devices and communications infrastructure was provided directly to us by Arqiva.

2.3 Framework for assessment of costs and benefits

Figure 2 shows the framework for the assessment of costs and benefits. We have assessed these at the water company level, and aggregated for the regional (across England) and national level (for England and for Wales). There are four high level cost categories: meter and device acquisition; meter and device installation; communications equipment costs and back office and programme costs.

There are seven high benefit categories of benefit. Six of these are private benefits in that they accrue to the water company and therefore offset the costs in terms of the impact on customer bills. These are: more efficient leakage control costs; operating cost savings from reduced consumption; capacity benefits of reduced consumption (deferred investment or opportunity to trade water); reduced meter reading costs; improved infrastructure management; and improved forecasting data.

The seventh benefit, the reduction in carbon emissions, is a benefit to society but does not affect the level of bills paid by customers.

All of these benefits and costs are included in the CBA model and are used to calculate benefit-cost ratios (BCR) and the net present value (NPV) of net benefits.

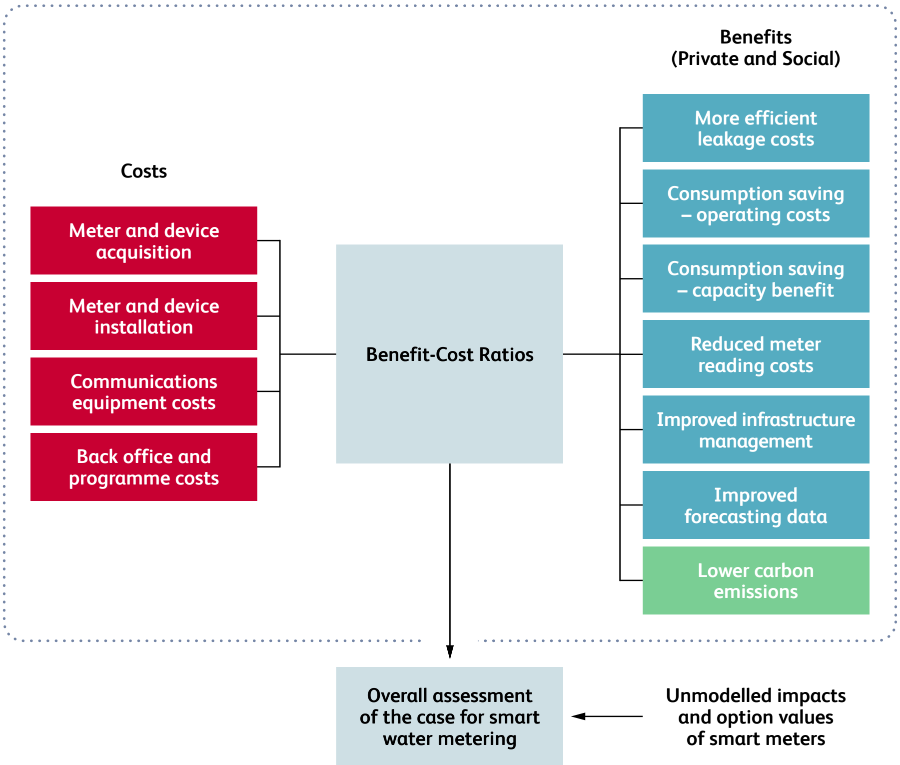

Figure 2: Framework for assessment of costs and benefits. Source: Frontier / Artesia.

At the same time our analysis has identified additional impacts of WSM that have not been included in the model. The reason for this is that there is not sufficient evidence to quantify these impacts or that the emergence of these impacts is too uncertain at this stage. Nevertheless we describe these additional impacts in Section 3 of this report. We consider that they are relevant to any overall assessment of the case for WSM, particularly as they are almost all additional benefits of smart metering and therefore the BCRs and NPVs calculated by the model can be considered to be conservative estimates.

2.4 Scenario based analysis

We have modelled two scenarios for the roll-out of WSM. These two WSM scenarios are compared to a base case scenario that reflects existing proportions of properties charged on a metered basis, and how this is forecast to change in the future. Our analysis is at the water company level as these vary quite widely between water companies based on a range of factors including:

- The historic roll out of water meters. For example, South West Water currently meters around 82% of households, reflecting a high number of customers opting to pay on a metered basis over many years; Southern Water and South East Water both implemented 'compulsory' metering programmes in recent years, resulting in metering rates of 88% and 89% respectively. In contrast, Portsmouth Water has the lowest metering rate in England and Wales at 35%.[2]

- The 'water stress' status of different company regions. This classification (set by the Environment Agency) determines if a water company can consider the option of charging by metered volume for all customers (known as compulsory metering) in its Water Resources Management Plans. This classification was updated to include more companies in July 2021.[3]
- The water stress status of a company, combined with its own strategies for managing supply and demand will determine their plans for metering.

Water companies also use different metering technology. Traditionally water meters were predominantly mechanical in design with a register of the volume passing through the meter that has to be read manually, usually once or twice a year. These are generally referred to as 'dumb' meters. The majority of meters currently installed are dumb meters.

Several companies have installed large numbers of meters which have a digital register that can be read remotely by meter readers driving past, collecting data as they go. These are known as Automatic Meter Read (AMR) meters. Although AMR meters can be read more efficiently, and therefore more frequently, many companies only collect data from them once or twice a year.

Smart meters have become more prevalent in the past 5-10 years. These meters are able to collect and send water use data to the water company, and provide the same data to the customer, at a much higher frequency, such as hourly or even every 15 minutes. Thames Water has installed over 500,000 smart meters in its region and is continuing this rollout. Anglian Water are planning to move fully to smart meters by 2025.

Details of the scenarios are set out Figure 3 below. The term 'progressive' refers to scenarios with a co-ordinated roll-out over a single five year period. In the earlier stages of the analysis we considered options for slower roll-outs of smart metering, but these options were not reflected in the final chosen scenarios.

	Base case (Business as Usual)	Progressive-optional	Progressive-compulsory
Timeframe for meter roll-out	As per WRMP19 The existing metering policies, which include: All new builds have a meter. Optant (when a customer requests a metered account). Change of occupier.	2025/26 - 2029/30 Existing policies to start of 2025/26	2025/26 - 2029/30 Existing policies to start of 2025/26
Target meter penetration	As per WRMP19 planning tables	80% or Base Case if higher[4]	80% or Base Case if higher
Legacy meter type	Could be • 'dumb' meters (meters that have a single total volume register that require manual reading). • AMR meters (meters with radio technology inbuilt and may include some inbuilt intelligence, that can be read by a walk-by or drive-by receiver). • AMI meters (meters that can be read over a fixed network and can include some in-built intelligence). Assumed 10% of legacy meters and retrofits are AMR and the remainder are dumb. Separate profiles for Anglian and Thames based on current policies.		
New meter type	Any of the above, based on current company plans	AMI meters	AMI meters
Replacement of legacy meters	End of life	Replaced during roll-out	Replaced during roll-out
Household numbers	Household and population numbers are defined by the final planning tables in WRMP19.		
Customer billing	All metered customers have measured charging	New metered customers can choose measured or unmeasured billing	New metered customers switched to measured billing after 3 years

Figure 3: Water smart metering scenarios. Source: Frontier / Artesia.

Under the progressive-optional scenario, soon after a property has a meter fitted (e.g. at three months), the customer is provided with a bill comparison comparing their current unmetered tariff to the new metered tariff. This is carried out to encourage households to voluntarily opt onto a metered charging account. During the period before their first bill, customers also receive literature and support on how to reduce consumption.

We have assumed that 45% of households switch within one year (based on the estimated proportion who will gain financially from a switch[5]). After that, we have assumed that 10% per year will switch due to optants and change of occupier. The remaining properties will stay on an unmetered account but will still get benefits from the utility analysing the data to deliver all the leakage benefits and partial benefits from PCC (by targeting leaky loo repairs where high continuous flows are identified). The WSM progressive-compulsory scenario is the same as the WSM voluntary scenario, except that all properties will be switched to a metered account after three years.

The WSM progressive-optional and progressive-compulsory scenarios are compared to the base case (business-as-usual) scenario.

2.5 Core model specification

We set out the specification for the policy choices that companies need to make, and then for the inputs with uncertainty to show the values which we have used.

Parameter	Value or assumption
Policy choices	
Target meter penetration	80% or Base Case if higher 70% for Thames due to large number of hard to reach properties
Meter roll-out strategy	Progressive – target meter penetration achieved in 5 years by 2029/30. Co-ordinated roll-out.
Legacy meters	10% of legacy meters and retrofits are AMR and the rest dumb (Thames and Anglian have specific Base Case scenarios)
Other inputs	
Charging profile	Compulsory – all switched to measured charging after 3 years Optional – 45% switch in 1st year, 10% switch per year thereafter
Consumption reduction (assumed measured charging)	Unmeasured to dumb / AMR: 12% reduction Unmeasured to smart: 17% reduction Dumb / AMR to smart: 5% reduction Additional 5% reduction in peak demand for smart meters
Leakage cost efficiency	15% improvement under smart metering
Meter installation costs	£65 for easy installation £275 for difficult installation (applies to all unmeasured properties) 20% reduction in these costs if metering is rolled-out in co-ordinated programme area by area
Infrastructure management costs	£0.80 per property per year
Avoided forecast data costs	£0.50 per property per year
Carbon prices	Low traded values published by BEIS

Figure 4: Core model specification. Source: Frontier / Artesia.

2.6 Limitations of modelling

This work identified a longer list of benefits and costs but not all of these quantified in this analysis. This analysis captures the most material of the benefits and costs, and it has primarily been additional benefits that have not been quantified. The cost of embedded carbon is the only cost identified in this work where there is insufficient data on what these costs would be for smart metering, and what they are at a company level under business as usual. We therefore believe the overall benefit to cost ratios to be conservative estimates.

The list of costs and benefits are discussed in Section 3 of this paper. The list of benefits that have not been included in the modelling includes known benefits where there was not sufficient information to quantify them. For example, the health benefits from no longer needing to do manual meter reads that include the risk of injuries. It also includes benefits that we have not quantified because there is uncertainty about the extent of these benefits and when they will occur. This includes benefits from joining up smart data from across sectors, to provide a new range of value added services to customers.

3.0 Benefits of smart metering

This assessment of the case for rolling out a smart water metering infrastructure in England & Wales is made against a backdrop of a growing understanding of the challenges to the sector posed by the climate change emergency.

In this section we set out the challenges facing the sector, how smart metering can meet these, and the costs and benefits of smart metering included in our model.

3.1 Challenges facing the water sector

Water UK represents water and wastewater service suppliers for England, Scotland, Wales and Northern Ireland. In March 2021 they published a consultation document that set out a vision for the water sector in 2050 Vision.[6] This Vision documented highlighted five key challenges facing the water sector.

1. The climate emergency. Climate change increases the risk of increased water scarcity, flood risk, extreme weather events, and reduced water quality. The industry has committed to cutting operational carbon emissions to net zero this decade.

2. Population growth. Increased population will place even more pressure on water resources, asset health and the environment.

3. Future-proofing asset health and skills. The water sector needs to increase the health and resilience of its built and natural assets, and to future proof the skills base.

4. Increased environmental standards underpinned by societal expectations. The sector will need to reflect expectations around improving the environment and addressing the biodiversity emergency.

5. Increased customer, community and societal demands. The sector faces increasing scrutiny on companies and higher customer experience and environmental expectations.

At the same time, the Vision document identifies the opportunities for the sector to deploy technology and innovation in order to meet these challenges, and recognises this will continue to present exciting new opportunities.

"Over the next 30 years, the climate emergency will threaten every aspect of the water sector, increasing the risk of drought, flooding and biodiversity loss. Significant population growth, combined with the climate emergency, will place even more pressure on the environment, water resources, and the state of our pipes and equipment."
Water UK

The focus on meeting the challenge of water scarcity and climate change is emphasised in Defra's Draft Strategic priorities for Ofwat, published in July 2021.[7]

The document highlighted the importance of reducing demand for water and improving leakage performance. It stated that:

"Reducing demand for water can both relieve pressures on water supply and contribute to climate change adaptation and mitigation by increasing our resilience to extreme drought. Alongside increasing supply, water companies must act to reduce demand for water in a way that represents best value for money in the long-term.

We expect Ofwat to:

- **Challenge water companies to halve leakage by 2050. We expect Ofwat to monitor progress towards this target.**

- **Support and encourage water companies to develop a consistent approach to address leakage on customers' own pipes. This could include provision for identifying leaks, agreeing who is responsible for repairs and replacement, and monitoring the impacts of this."**

The Environment Agency has also set out a National Framework for Water Resources, which explores England's long-term water needs. It states that:

"If no action is taken between 2025 and 2050 around 3,435 million extra litres of water per day will be needed for public water supply to address future pressures."[8]

The national plan for England requires water companies to collaborate in regional groups They will produce regional plans which will inform water company Water Resources Management Plans and will:

- Reduce demand – to 110 litres of water per person per day by 2050 and drive down water use across all sectors.

- Halve leakage rates by 2050.

Delivering these goals could go a significant way to fill the deficit in water resources identified, but will require new approaches to demand and leakage reduction.

Any assessment of the case for water smart metering should consider its impact in relation to these important challenges and we have endeavoured to address this in our analysis.

3.2 Scope for smart metering to meet the challenges

Water smart metering can help the water industry to meeting the challenges that it faces in a number of ways.

- Reduced water consumption. Many households across the country do not have a water meter and do not pay on the basis of consumption. Switching to a metered supply encourages households to reduce consumption. In addition, switching from an existing dumb meter to a smart meter promotes further reduction e.g. by identifying continuous flows that could be leaks or through targeted customer communication to particular groups based on detailed patterns of consumption. This helps meet the challenge of water scarcity and population growth.

- Reduced carbon emissions. Lower water consumption reduces the amount of energy used by the water companies and it reduces energy use in the home for heating water. This will reduce carbon emissions, particularly during the period when the electricity sector is decarbonising its generation.[9] Smart meter reads also reduces traffic.

- More efficient leakage reduction. Water companies have to achieve significant reductions in leakage. Smart meters allow for more efficient leakage control, in particular by locating leaks on customers' pipes (one of Defra's key priorities for the sector) and providing more data to improve leakage targeting on the distribution network.

- Better asset management. Smart metering would work alongside smart technology on the companies' networks to provide a better understanding of asset performance and more efficient planning of maintenance.

- Better engagement with customers. Smart metering enables accurate and timely customer billing and facilitates a wider range of engagement with customers. By identifying and enabling internal leaks to be quickly fixed, smart metering benefits customers through minimising the risk of volatility and shocks in water bills. Furthermore, smart metering can enable wider applications of smart data within households and businesses.[10]

The routes for achieving these benefits are summarised in Figure 5.

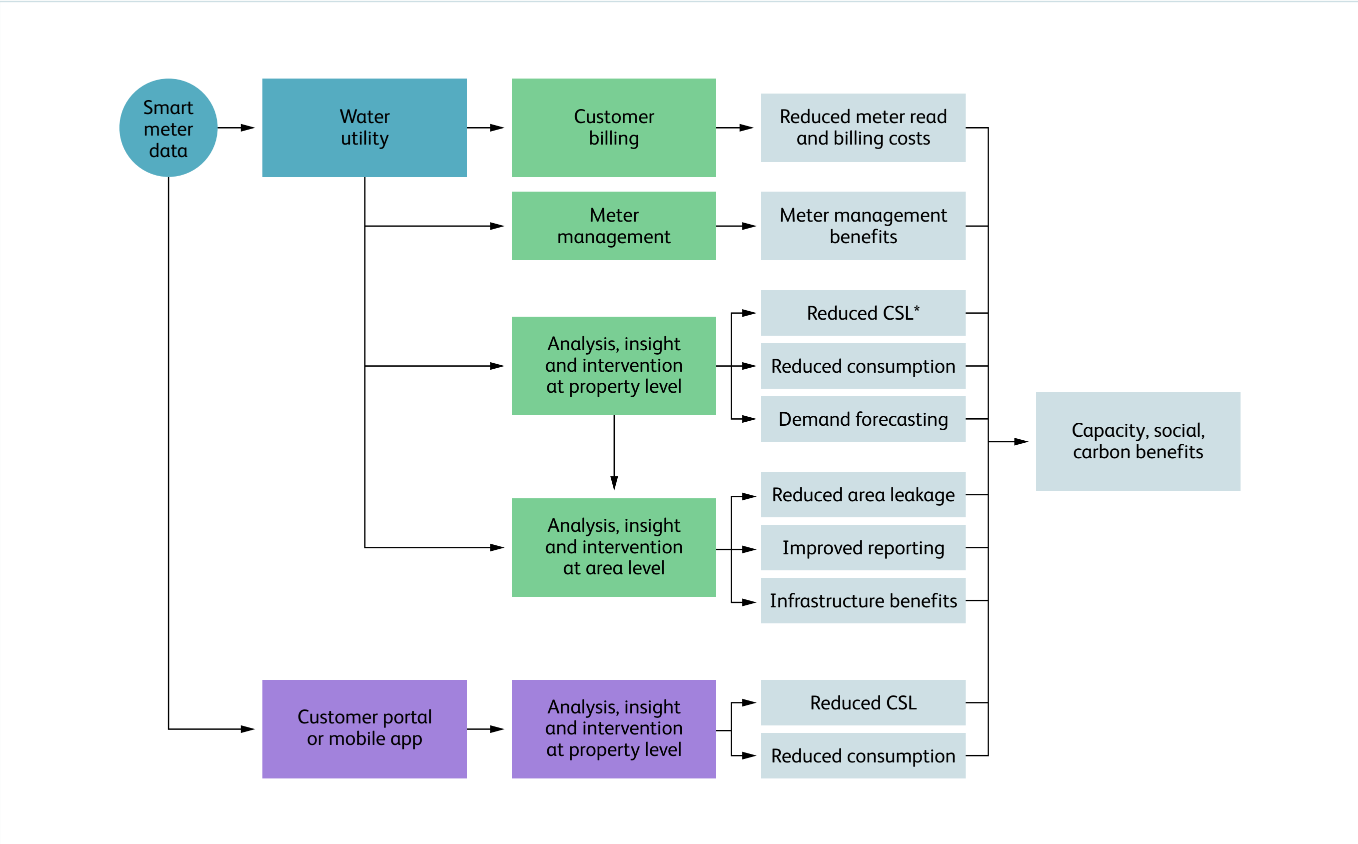

Figure 5: Benefits of water smart metering. Source: Frontier / Artesia.

*Customer side leakage

This shows that, in principle, smart metering can help to address some of the key challenges facing the water sector. In the next Section we summarise the results of our cost-benefit modelling of the roll-out of smart metering across England & Wales. The modelling has been undertaken at water company level, with results aggregated to give regional (across England) and national results (for England and for Wales). Where a water company sits across more than one region its results are apportioned to each region.

3.3 Assessment of benefits

Figure 6 provides an overview of each of the benefit parameters that have been included in the model.

Benefit	Description
Customer consumption	Data from smart meters will provide information on Customer side leakage (CSL); continuous use (plumbing losses), and variable use (people). This will enable the water company to provide help/support to identify source and resolve problem. This enables the company and/or customer to intervene, reducing CSL and consumption.
Additional capacity benefit	Smart metering will reduce demand and therefore defer the need for investment in supply-side options required by water companies, that would otherwise be required to maintain the supply-demand balance.
Carbon emissions from reduced energy use	The reduction in consumption means less water is supplied and less wastewater is treated, and less hot water is using in homes. We use carbon prices to value these reductions in consumption with the associated reductions in carbon emissions.
Improved infrastructure management – improved mains targeting	The improvement comes from using WSM meters to provide an understanding of the water balance within DMAs or areas within the network. This ensures targeting where the leakage exists, resulting in better targeting of mains replacement schemes and improved network condition.
Improved forecasting data – avoided costs of running PCC and NU monitors	Smart metering will provide time series data that can be used to support improved demand forecasts and improved night use estimates. The improved granularity of data from individual properties will remove the need for a separate 'monitor' (i.e. sample of properties) for deriving time series information about metered consumption

Figure 6: Description of benefits included in the modelling. Source: Frontier / Artesia.

3.31 Benefits not included in the modelling

The benefits outlined here are potential additional benefits beyond those that we have modelled. However, there is either or both insufficient data and too much uncertainty over the quantum of the benefits to include them in the modelling.

Benefit	Description
Health and Safety	Companies have previously reported the benefit of smart metering in terms of health and safety, as meter readers are no longer required to manually read meters, which can require working in the road, bending to read below-ground meters, etc. However, it has not been possible to quantify these benefits.
Bad debt management costs	Smart metering will provide more information on household water use and therefore should enable companies to intervene more effectively with households who are struggling to pay their bills. However, none of the companies we talked to were able to quantify the size of this benefit.
Data from non-household and network meters collected via fixed network	The fixed network created for households has enough capacity to capture and relay data from non-household and distribution network meters. For network meters the marginal cost of connecting the meter to the fixed network should be lower than other systems currently used. For non-households smart meters could be installed and benefits derived from identifying wasted consumption, leaking customer supply pipes, improved granularity of data. These benefits have not been included in the model as data on the benefits is not currently available.
Backflow detection	Smart meters allow backflow from a property into a main to be identified and resolved, reducing the potential risk of contamination of drinking water supply. This benefit has not been included in the model as robust data on the cost benefit is not available.
Value added services	Value added services from smart metering could include a reduction in insurance costs (because smart meters could detect potentially damaging internal leaks) and also support social care (for example alerting carers to no use over a period or continuous usage). These benefits have not been quantified because of lack of evidence.[11]
Option values around future tariff strategies	WSM permits a wider range of tariff options to be introduced in the future (e.g. peak demand tariffs, higher tariffs in drought periods). Such charging options may deliver greater consumption reductions and protect the resilience of water supplies. The option value of these tariff structures has not been included in the modelling.[12]
Customer energy bill savings from a reduction in energy consumption	We do not include the potential energy bill cost savings for households from using less energy, from heating less water. This is consistent with Ofwat's analysis in 2011 on "Exploring the costs and benefits of faster, more systematic water metering in England and Wales". Introducing a volumetric charge for water changes the value that consumers place on water: so the metering corrects a distortion in the price of water but because the energy prices do not capture the social costs of carbon there is no net welfare gain from using less energy. The conclusion is that it is appropriate to capture CO2e reductions but not energy cost savings. This may be a conservative assumption if, as a result of WSM, customers change behaviours in a way that reduces energy consumption but does not reduce customer welfare. For example, if customers derive the same welfare from a lower flow shower as they did from a higher flow shower.

Figure 7: Description of benefits not included in the modelling. Source: Frontier / Artesia.

3.4 Assessment of costs

Figure 8 provides an overview of each of the cost parameters.

Cost	Description
Meter acquisition costs (dumb, AMR, smart)	Industry standard estimates are used for dumb and AMR meter costs, of £18 and £40 respectively. A cost of £62 for the smart meter and endpoint has been provided by Arqiva, although we use the annual contract costs where this is just over £4 a year.
Meter installation costs (dumb, AMR, smart)	Easy meter installation costs of £65 per meter is applied for all retrofit and new metered properties. Hard meter installation costs of £275 per meter is applied for all unmetered properties, as these will require a new boundary box. A 20% efficiency reduction is applied to these costs for co-ordinated roll out programmes, compared to point-to-point. Both WSM scenarios are assumed to be co-ordinated.
Faulty meter costs (dumb, AMR)	We use an industry standard estimate of 1.3% of meters failing per year. Costs are estimated based on figures used for metering from analyses above. There are no faulty meter costs included for the WSM scenarios as these are including for in the warranty package provided by Arqiva. However, our core modelling assumptions conservatively does not include this avoided cost.
Meter reading costs (dumb, AMR)	This impact accounts for meter reading costs, including the purchase of any meter reading equipment and the on-going costs associated with routine meter reads and special reads. Costs for smart meter reading is zero as this is part of the package provided by Arqiva and covered in the network operation costs. There will still be meter reading costs in the WSM scenarios for remaining non-smart meters.
Communications equipment costs	This is only required for the smart metering scenarios. The cost is part of the package provided by Arqiva for the WSM scenarios in the network build and operation costs.
Back office costs: • Data management • Customer service and billing • Analytics • Security • Programme costs	This is based on a fixed capital cost per company (with an adjustment to reduce this value for the smaller companies with less than 750,000 household customers), plus an annual operational cost per connected customer.

Figure 8: Description of costs included in the modelling. Source: Frontier / Artesia.

Due to data limitations, we have not included the embedded carbon costs from WSM. This means we have not captured the carbon in the WSMs, or from operating the WSM network. Therefore our carbon figure are not net carbon figures. We do not expect that these figures would be as large as the avoided carbon emissions that have been included and we have compensated for this by including the low range of carbon prices from BEIS in the assessment of benefits.

4.0 Positive social case for WSM roll-out across England & Wales

In this Section we set out the results for England & Wales for both the ‘progressive-compulsory’ and ‘progressive-optional’ scenarios. These results have been aggregated from water companies to show the national results.

4.1 Positive social case for WSM roll-out across England & Wales

4.1.1 Progressive roll-out, compulsory charging scenario

Figure 9 shows the results for the progressive compulsory scenario, where customers are automatically switched onto a measured charging basis no later than 3 year after the meter is installed. It shows that both the NPV total benefits exceed the NPV of the incremental costs of the water smart metering scenario. The total benefits include the private benefits plus the value of reduced carbon emissions. The total benefits therefore reflects the value of the programme as a whole to society.

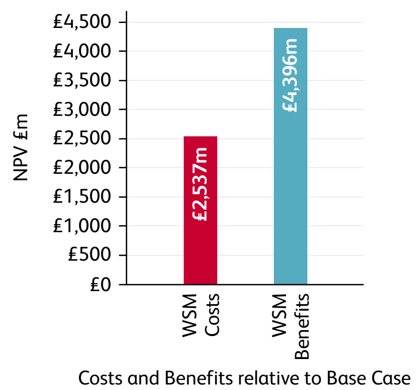

Figure 9: CBA for progressive-compulsory scenario – England & Wales. Source: Frontier / Artesia.

Figure 10 shows that the total net benefits in this scenario is £1,859m net benefit (benefits minus costs) and the BCR is 1.73.

	Impact	BCR
Total benefits	£4,396 million	
Total costs	£2,537 million	
Net benefits	£1,859 million	1.73

Figure 10: Progressive-compulsory scenario – Summary – England & Wales. Source: Frontier / Artesia.

4.1.2 Progressive roll-out, optional charging scenario

The results described above relate to a WSM scenario which assumes that households are automatically transferred onto a metered charging basis. However, water companies may prefer to give their customers the option to stay on a unmetered charge should they wish to do so.

Therefore we have also modelled a scenario where households retain the choice of metered or unmetered charging basis. This is the progressive-optional scenario. Figure 11 shows the overall results for the progressive-optional scenario for England & Wales.

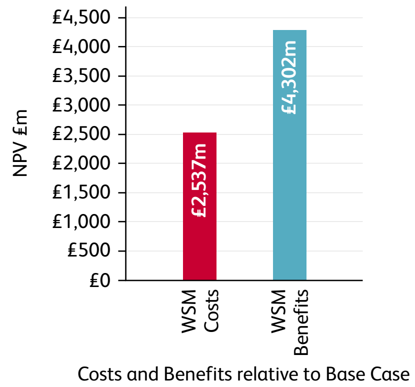

Figure 11: CBA for progressive-optional scenario – England & Wales. Source: Frontier / Artesia.

The table in Figure 12 shows that the total net benefits (benefits minus costs) are £1,764m in NPV terms over the 30 years. The benefit to cost ratio is 1.70.

	Impact	BCR
Total benefits	£4,302 million	
Total costs	£2,537 million	
Net benefits	£1,764 million	1.70

Figure 12: Progressive-optional scenario – Summary – England & Wales. Source: Frontier / Artesia.

The net benefits are slightly lower in this scenario than the progressive-compulsory scenario. This is driven the lower reductions in demand as customers switch onto a measured charging basis less quickly than under the compulsory scenario and therefore there is a smaller demand response to the price signals under a measured charging structure.

Nevertheless the difference in the benefits case across the two scenarios is not great.

For the remainder of the analysis, we focus on the detailed results of the progressive-compulsory scenario.

4.1.3 Analysis of impacts

Figure 13 shows the breakdown of the results for England & Wales by category of impact.

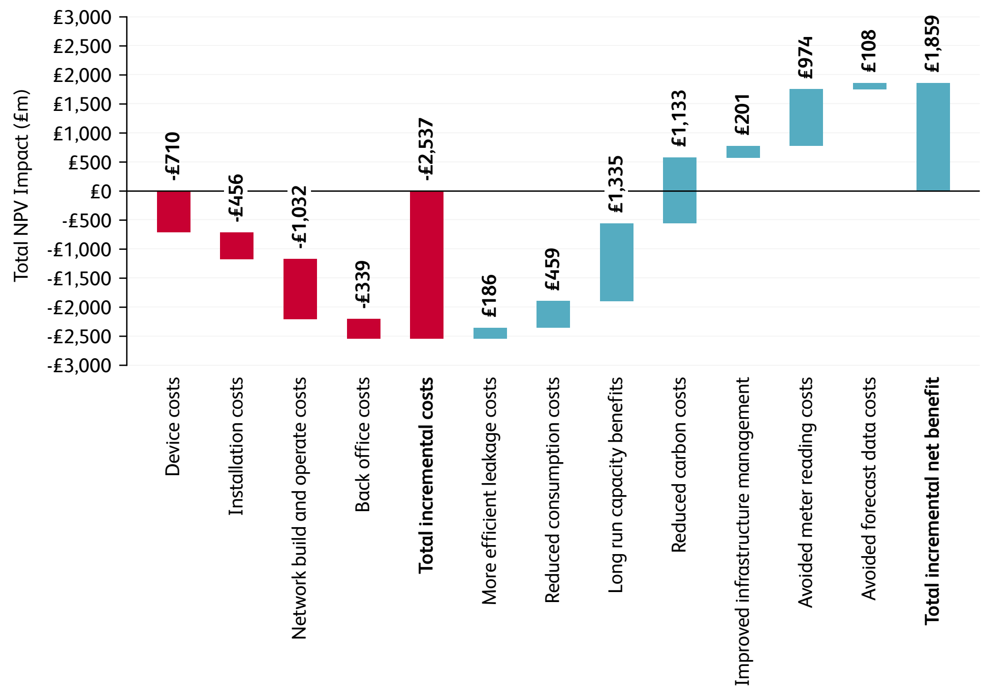

Figure 13: Analysis of impacts – Progressive-compulsory scenario – England & Wales. Source: Frontier / Artesia.

The main findings from this analysis are:

- The main cost category is 'Network build and operate costs'. This is based on the Arqiva / Sensus contract costs and includes the communications infrastructure.
- 'Device costs' are the second biggest cost category. This is the net device costs of the Arqiva WSM and the dumb/AMR meters that would have been purchases under the BAU scenario. Meter installation costs and back office costs are also material though smaller in scale.
- The two most significant benefits are the capacity benefit of reduced water consumption and the value of reduced carbon emissions. The lower consumption allows companies to defer alternative investment in other demand reduction or new supply schemes.
- The benefit of lower carbon emissions gradually declines over the 30 year horizon, reflecting the planned de-carbonisation of the energy sector. Nevertheless the assumed reduction in home energy use as a result of smart water metering provides a material carbon benefit.
- Reduced meter reading costs and lower operating costs due to lower consumption are the other material benefits.

4.2 Results by water company area and by region

In this Section we set out the results for each water company, as well as the regional results. Where a water company sits across more than one region its results are apportioned to each region.

The results of the CBA modelling at the level of each individual water company is shown in Figure 3. For each company the benefit-to-cost ratio (BCR) exceeds 1.0, i.e. the roll-out of WSM delivers positive net benefits compared to existing metering plans.

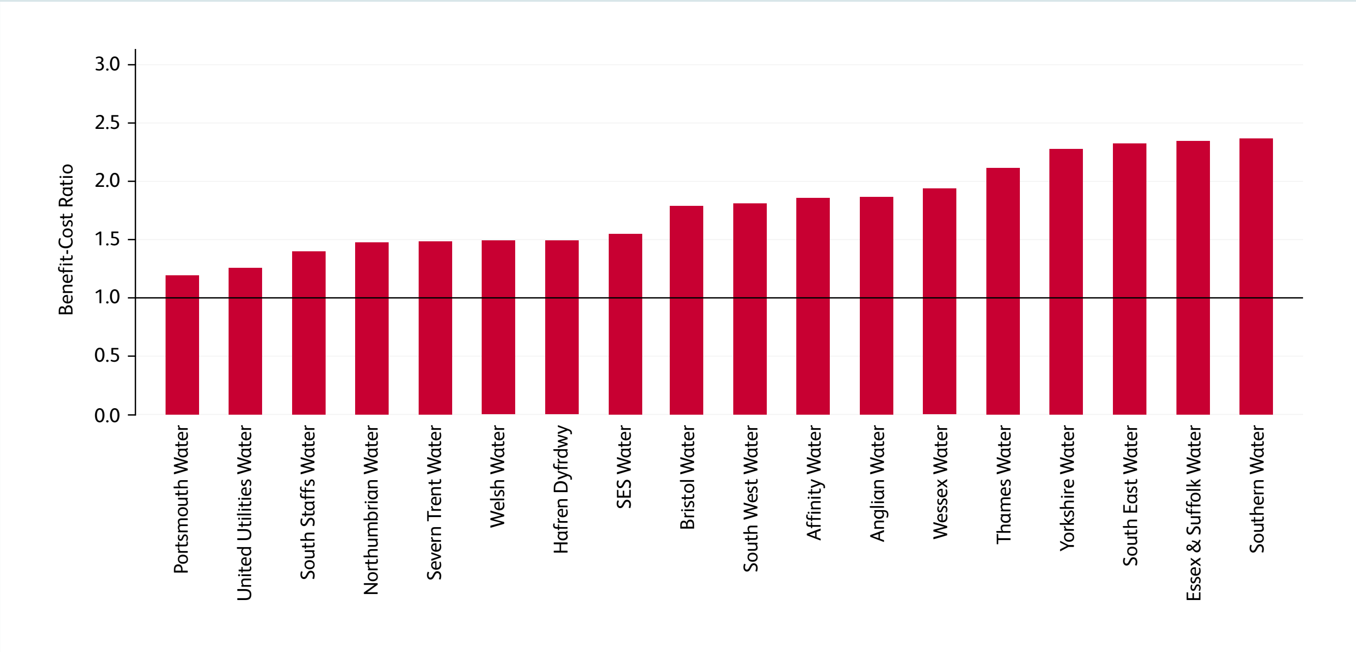

Figure 14: Benefit-Cost Ratios by water company area. Source: Frontier / Artesia.

At the same time there is material variation in the BCRs across the companies. This variation is driven by a number of factors.

- Existing meter penetration. Areas with higher existing meter penetration have higher BCRs as a result of lower incremental costs of installing meters in existing boundary boxes.
- Greater water scarcity. Areas with higher cost new water resource options, due to water scarcity, have greater benefits. Smart metering drives a reduction in demand which delays or removes the need for supply-side interventions.
- Small company costs. We have assumed that smaller water companies will face proportionally higher back office and programme costs.

Figure 15 shows the BCR results (including carbon benefits) for the progressive-compulsory scenario at the regional level across England & Wales. In all regions there is a positive BCR result (i.e. greater than 1), showing that smart metering is cost-beneficial in all regions.

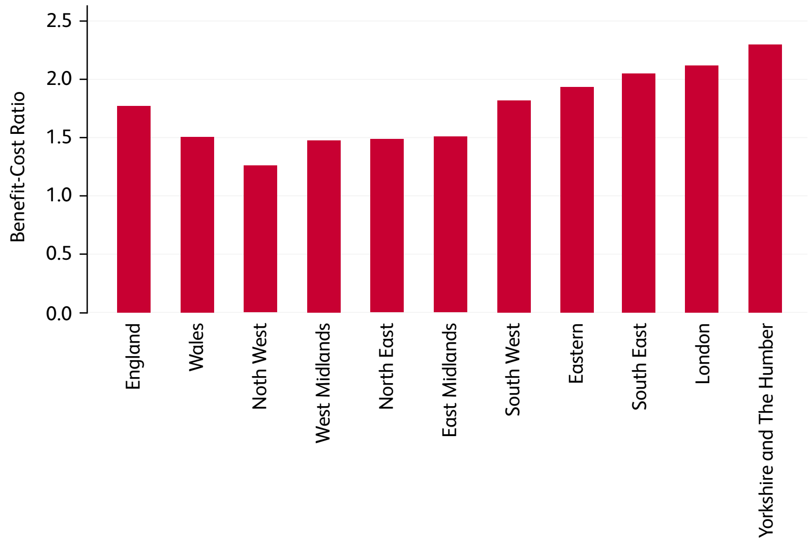

Figure 15: Benefit-Cost Ratios by region. Source: Frontier / Artesia.

4.3 Sensitivity analysis

To explore the sensitivity of the model to changes in key inputs, we have put together 6 different scenarios which to compare with the core scenario. These are based on changing 6 different input parameters which have a significant impact on the costs and benefits. The 6 variables are:

1. The installation cost for 'easy' installations.

2. The installation cost for 'difficult' installations.

3. The efficiency factor for area by area roll-out.

4. The dumb meter water consumption reduction percentage.

5. The combined smart meter and dumb meter water consumption reduction percentage.

6. The carbon cost estimate.

These input variables are explained in more detail in Figure 16.The first three variables impact the cost of rollout, and explore the impact from under or over estimating these costs. The next two variables, the consumption reduction, impact the water savings, which directly impact the cost savings from reducing consumption and the long run capacity benefits, and explore impact of being overly optimistic about the water savings. The last variable is the carbon cost, and in the core model we have used the lowest estimate of carbon costs (low traded) and this explores the impact of using the next lowest value (low - overall).

Models inputs		Core	Low 1 – Consumption impact	Low 2 – Costs	Low 3 - Combined	High 1 - Carbon cost	High 2 - Costs	High 3 - Combined
Costs	Easy installation	£65	£65	£90	£90	£65	£50	£50
	Difficult installation	£275	£275	£350	£350	£275	£250	£250
	Roll-out efficiency	20%	20%	10%	10%	20%	20%	20%
Benefits	Dumb meter consumption reduction	12%	8%	12%	8%	12%	12%	12%
	Dumb + WSM meter consumption reduction	17%	11%	17%	11%	17%	17%	17%
	Carbon cost estimate	Low - traded	Low - traded	Low - traded	Low - traded	Low - overall	Low - traded	Low - overall

Figure 16: Sensitivity scenarios. Source: Frontier / Artesia.

These sensitivity scenarios are summarised below, with results in Figure 17. Even with the most conservative assumptions in the low scenario we find a positive BCR for England and a neutral BCR (1) for Wales.

- Low scenario 1. Here we explore reducing the combined dumb consumption reduction to 8% and the smart meter reduction to 3% (11% overall). This, as expected, reduces the benefit cost ratio across all companies, however all except Portsmouth (0.9) have BCRs greater than one.

- Low scenario 2. Here we use the core values for consumption reduction and increase the installation costs and at the same time reduce the installation efficiency factor. Again the BCRs reduce, however for all companies the BCRs are above 1.

- Low scenario 3. This represents the most pessimistic scenario which combines low scenarios 1 and 2; i.e. costs go up and consumption benefits go down. This has the largest reduction in BCR across all companies. In this scenario 13 of the England & Wales companies still have a BCR greater than one, 3 companies have a BCR of 0.9 and 2 companies have a BCR of 0.8.

- High scenario 1. Here we use all the core values, and apply the next lowest carbon cost (low - overall). This improves the BCRs across all companies.

- High scenario 2. We use all the core values, and reduce then installation costs. This also uses all the core values.

- High scenario 3. This represents the most optimistic scenario and combines high scenarios 1 and 2, with reduced installation costs and the 'low - overall' carbon cost. This produces the highest BCRs of all the scenarios.

		Core	Low 1 – Consumption impact	Low 2 – Costs	Low 3 - Combined	High 1 - Carbon cost	High 2 - Costs	High 3 - Combined
	England	1.8	1.4	1.5	1.2	2.5	1.8	2.6
	Wales	1.5	1.1	1.3	1.0	2.1	1.5	2.2
Companies	AFY	1.8	1.5	1.6	1.3	2.9	1.9	2.9
	ANH	1.9	1.4	1.7	1.3	3.4	2.0	3.7
	BW	1.8	1.4	1.6	1.3	2.7	1.8	2.8
	HDD	1.5	1.1	1.4	1.0	2.1	1.5	2.1
	NW	1.5	1.1	1.2	**0.9**	2.1	1.5	2.2
	ESW	2.3	1.8	2.1	1.5	3.3	2.4	3.3
	PRT	1.2	**0.9**	1.0	**0.8**	1.7	1.2	1.8
	SES	1.5	1.3	1.4	1.1	2.4	1.5	2.4
	SEW	2.3	1.8	2.1	1.6	3.3	2.3	3.4
	SRN	2.4	1.8	2.1	1.6	3.4	2.4	3.4
	SSW	1.4	1.1	1.2	**0.9**	2.1	1.4	2.1
	SVT	1.5	1.1	1.2	**0.9**	2.0	1.5	2.1
	SWW	1.8	1.4	1.6	1.3	2.8	1.8	2.8
	TW	2.1	1.6	1.8	1.4	2.9	2.2	3.0
	UU	1.2	1.0	1.0	**0.8**	2.0	1.3	2.0
	WW	1.5	1.2	1.2	1.0	2.2	1.5	2.2
	WSX	1.9	1.5	1.7	1.4	2.9	1.9	2.9
	YKK	2.3	1.8	2.0	1.5	3.2	2.3	3.3

Figure 17: Societal BCRs with different sentsitivities – progressive-compulsory. Source: Frontier / Artesia.

5.0 Investment case for water companies

The results in the preceding Sections are based on the total benefits of the WSM programme. This includes the social impacts and, in particular, the benefit of reduced carbon emissions. This is the appropriate method to assess whether WSM is a beneficial solution for society as a whole.

It is also relevant to consider the case from the perspective of the water company and to exclude the wider social impacts. This identifies the impact on water company costs and therefore the impact on household water bills.

Figure 18 shows the costs to the water companies of the WSM programme, the benefits to the companies of the programme and the total benefits.

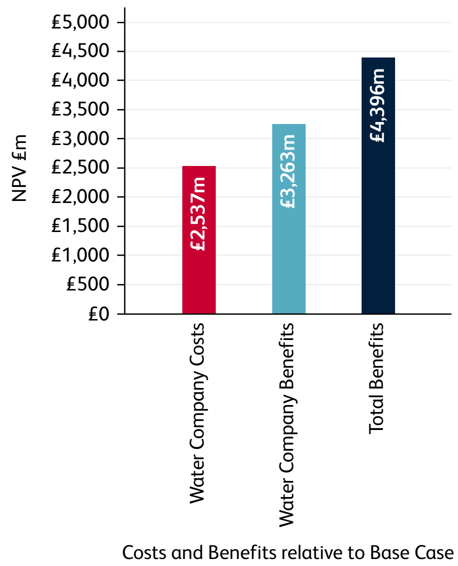

Figure 18: Investment case for water companies: England & Wales. Source: Frontier / Artesia.

The benefits to the water companies are less than the total benefits, on account of the social benefits of lower carbon emissions. However, the water company benefits are in excess of the water company costs. This means that there is investment case for WSM roll-out from the perspective of the water companies, even if we ignore the social benefits.

Furthermore, the benefits of WSM to water companies come in the form of savings in other costs (e.g. cost savings on leakage control, network management and avoided costs of other water resources).

The WSM programme will cost £2,537 million (NPV over 30 years) but will result in offsetting cost savings for water companies of £3,263 million. This net cost saving of £726 million will result in lower average bills for households.

We discuss the implications for customer billing further in the next Section.

6.0 Implications for customer billing

The results described in Section 5 relate to a WSM scenario which assumes that households are automatically transferred onto a metered charging basis. Specifically it assumes that following installation of a meter households have a choice about switching from unmetered to metered charging but those that do not choose a metered charge are automatically switched after three years.

6.1 Optional charging scenario

This scenario delivers the greatest benefits because areas where more customers are billed on a metered basis will, on average, have lower consumption. However, water companies may prefer to give their customers to option to stay on a unmetered charge should they wish to do so.

In Section 4 we showed the results of a scenario where households retain the choice of metered or unmetered charging basis (progressive-optional). The results of this scenario are re-presented below, compared to the compulsory charging scenario.

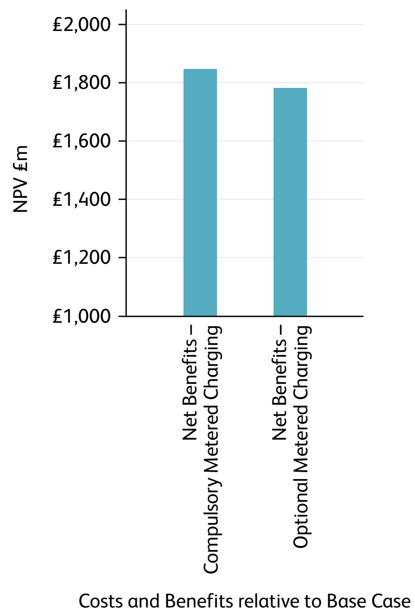

Figure 19: Alternative scenario for metered charging. Source: Frontier / Artesia.

The optional charging scenario does reduce the net benefits compared to the compulsory charging scenario but the impact is not great. The BCR falls from £1.73 of benefit for every £1 of cost to £1.70 of benefit for every £1. There is still a strong cost-benefit case in this scenario.

There are two main reasons why the difference is relatively small. First, even in the optional scenario a high proportion of customers will switch to a metered charging basis over time. Second, many of the benefits of WSM, for example finding supply-pipe leaks or internal leaks, flow from the data that smart meters provide and do not depend on the basis for charging.

6.2 Household bill impacts

The CBA results show a positive BCR for England & Wales, even focussing just on private costs and benefits. What this means is that the rollout of smart metering would result in lower household bills, on average and across time and regions.

Figure 20 which shows the time profile of net benefits over time. The annual net benefits are negative until 2030/31 and then strongly positive until the meter replacement in the first half of the 2040s.

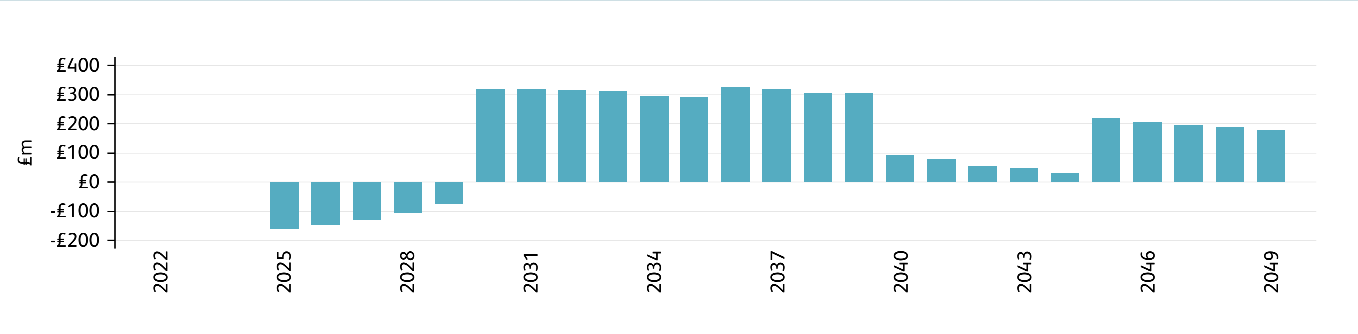

Figure 20: Time profile of CBA benefits. Source: Frontier / Artesia.

The analysis in section 5 identified that just focussing on the private costs faced by the water companies the roll-out of WSM would deliver net benefits of £726m. This reduction in costs incurred by the water companies means that, on average, household bills should be reduced as a result of WSM. In terms of the profile of household bills over the period we note that Ofwat's regulatory methodology can allow cost recovery to be spread over the lifetime of the assets, so that it matches the profile of benefits. This would smooth the bill impact on households and allow bill increases in the initial period to be avoided.

The private benefits of £726 million would equate to a saving of average household bills of just over £70 per household over the period, or nearly £3 per household per year.

7.0 Policy implications

Defra's draft Strategic Policy Statement for Ofwat states that "water companies must act to reduce demand for water in a way that represents best value for money in the long-term".[14]

Defra expects Ofwat to "Support and encourage water companies to develop a consistent approach to address leakage on customers' own pipes" and "Hold companies to account for their contribution towards reducing personal water consumption to 110 litres of water per head per day (l/h/d) by 2050."

This report demonstrates that smart metering does provide a cost-beneficial way of reducing demand, and will both enable the reduction of customer supply pipes and help reduce personal water consumption.

This report provides a clear methodology for assessing the costs and benefits of smart metering. The model developed as part of this project can be applied to individual companies to cost smart metering interventions in a consistent, industry-standard way.

The Environment Agency Water Resources Planning Guideline states that water companies in England, which are in areas of serious water stress, should evaluate charging by volume based on universal metering. They should also evaluate whether compulsory metering would be one of their preferred options. These companies should also consider smart metering, metering on change of occupier and metering street-by-street with comparative billing as options in your plan.

The responsibility for planning and delivering WSM lies with the regulated water companies. The companies develop their investment plans within a policy and regulatory framework that is set by Government, EA and Ofwat. This framework should ensure that beneficial programmes such as WSM are supported and encouraged.

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10. For example, BEIS consultation on Smart data: putting consumers in control of their data and enabling innovation, September 2020, https://www.gov.uk/government/consultations/smart-data-putting-consumers-in-control-of-their-data-and-enabling-innovation (accessed 12 October 2021).

11. For example https://www.hiscox.co.uk/home-insurance/leakbot-info describes how an insurance company offers a free leak detection device and engineer support to repair leaks, but does not relate this to the level of premiums.

12. Chapter 5 of the UKWIR report (2012) describes how option values can be applied into a CBA framework.

13. This can be achieved through lowering the run-off rate on existing RCV or by extending the assumed asset life for new assets.

14. Defra, The government's strategic priorities for Ofwat, Draft for consultation, July 2021, https://consult.defra.gov.uk/water-services/government-new-sps-consultation/supporting_documents/newstrategicpolicystatementofwatdraftforconsultation.pdf (accessed 12 October 2021).

About the authors

Frontier Economics is a consulting firm with over 250 economists across London, Berlin, Brussels, Cologne, Dublin, Madrid and Paris. We specialise in competition, regulation and strategy, across all major sectors and areas of economic analysis.

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Arqiva is a communications infrastructure and media services company, operating at the heart of the broadcast and utilities industries in the UK.

Arqiva builds and monitors the digital infrastructure which facilitates the operation of smart water networks, through its dedicated and secure radio network. In addition, Arqiva has a growing portfolio of complementary services designed to support both water companies and consumers to manage water use and minimise leakage and also address issues across the network from clean water generation through distribution to waste water and sewage.

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