artesia

frontier economics

UNLOCKING BENEFITS THROUGH DATA AND METERING

A case for investment in AMI smart water metering

MAY 2022

CONTENTS

frontier economics

frontier
economics

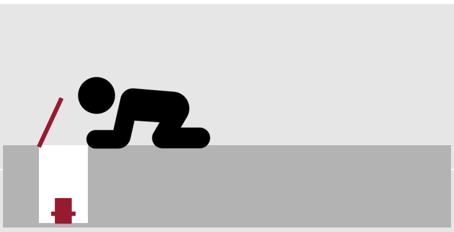
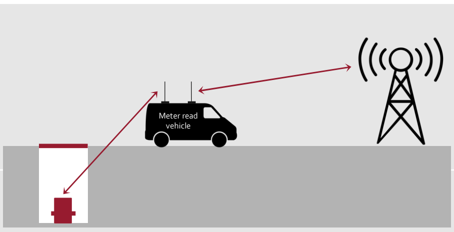
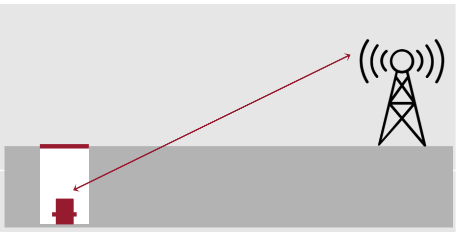
SUMMARY OF FINDINGS AND RECOMMENDATIONS

As the next round of investment planning approaches, water companies are faced with a critical choice. This choice, at its most basic, is about the type of water meters the companies install at customers' premises. While this may seem as simple as choosing the lowest cost solution, it is much more important and far-ranging than that. The choice will help define how ambitious a company can be in delivering future improvements for customers and society in the face of large external challenges. In particular, it will indicate whether the company is willing and able to unlock the potential of data to transform the way it provides services to customers and the environment - or whether it is content to take a more incremental approach.

The water industry's key strategic challenges are well understood: the population is expected to grow, climate change may both restrict the availability of water in the environment and increase consumer demand, and customers' expectations for the resilience and quality of service continue to increase. In response, companies have committed to cutting water leakage significantly, to achieve very material reductions in water demand per capita, to reach operational net zero carbon by 2030 and to continue to reduce the numbers of service outages experienced by customers from their ageing networks.

In a November 2021 report for Arqiva[1] we analysed the costs and benefits of an Advanced Metering Infrastructure (AMI) roll-out across England and Wales by 2030. That report focussed on key consumption, leakage and operational benefits of smart metering and identified significant net benefits from the modelled AMI roll-out. In doing so it highlighted the benefits of accelerating the roll-out of smart metering across England and Wales with estimated net benefits of £1.9bn overall.

In this follow-on report we consider how the case for AMI differs to that of Automated Meter Reading (AMR) technology, and focus on adaptability and leveraging the power of data in more detail. Compared to manually read "dumb" meters, AMR can increase the efficiency of the meter reading process and bring added benefits of leak alarms. However, AMR meter readings still depend on company agents driving past meters whenever readings are needed to download data, incurring energy and meter reading costs in the process. In contrast, AMI meters can continually collect and send data over a communication network to data storage facilities. It is this ability of AMI to collect large volumes of granular data in a timely manner that really unlocks the benefits of metering data.

'Dumb' manual read	Automatic meter reading (AMR)	Advanced meter infrastructure (AMI)
		
▪ Visual read 1 – 2 times a year	▪ Drive-by or walk-by reads 1 – 2 times a year	▪ Hourly data transmission allowing high data frequency

Our findings in this report are based on the expected costs and benefits across England and Wales, alongside a qualitative assessment of other key impacts assessed from the perspective of both water companies and their customers. The analysis is based on evidence obtained from company roll-outs of both technologies,

[1] Frontier Economics and Artesia, Report: Cost benefit analysis of water smart metering, November 2021

cost and performance data provided by Arqiva and international experience through a number of case studies.

CASE FOR AMI INVESTMENT

Finding 1 – AMI can enable significantly greater benefits for water customers and wider society than AMR. Companies can therefore be more ambitious in both the scale and scope of benefits they expect to achieve through an AMI approach:

- We estimate that AMI will deliver between £1.3bn and £1.85bn additional net benefits compared to AMR across England and Wales, depending on just how ambitious the companies are in making full use of the additional data (see Figures 1 and 2 below). These measured benefits stem largely from enabling reduced water consumption, lower carbon emissions, increased leakage cost efficiency and avoided data and meter costs. In addition, there are further benefits that have not been quantified (see Finding 2).

- The level of ambition that companies apply to their metering programme will derive from their overall long-term strategy for delivering outcomes to their customers and the environment. In particular, ambition relates to their plans for data strategy and customer engagement. We also note that companies can evolve this ambition over time, in response to emerging trends in the sector.

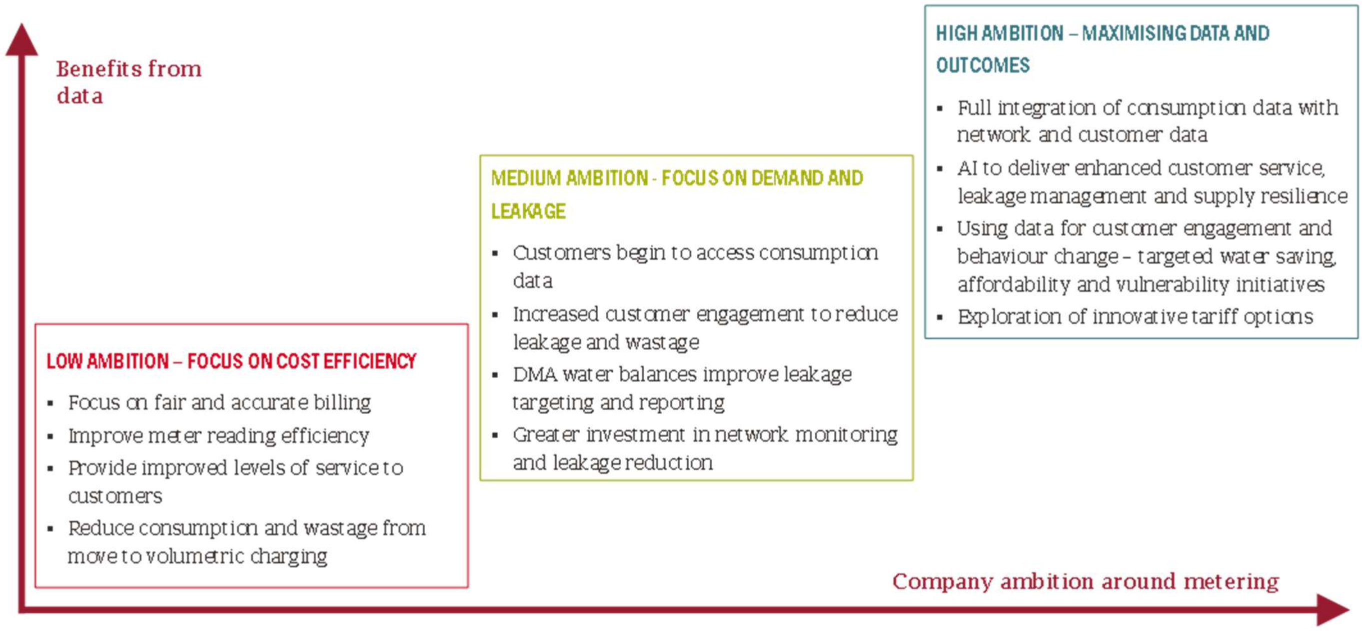
Finding 2 – Evidence shows that there are also likely to be many more wider benefits of AMI such as an improved customer experience, additional customer insight and in helping protect customers in vulnerable circumstances.

- We have also explored additional benefits achievable through metering, such as improved customer engagement and experience, additional customer insight and potential future solutions such as innovative tariffs. AMI outperforms AMR across these additional benefit areas as well, due to its ability to gather much more complete and actionable data.

- An AMI approach to metering is also more likely to allow companies to be rewarded rather than penalised by their regulators who will continue to set financial and reputational incentives by reference to the best-performing companies in these areas.

Figure 1 illustrates three levels of ambition that water companies may aspire to depending on their specific requirements and how these drive the benefits of smart metering. At the lowest level of ambition, data benefits will be low as the focus of metering programmes will be to increase efficiency of meter reading costs, relative to BAU costs. A higher level of metering ambition moves companies' focus to using data to unlock consumption and leakage benefits. In the highest ambition case, companies begin to fully utilise the power of data and insights from metering to deliver customer outcomes and resilient services. This would involve the integration of consumer insight from metering into BAU processes, improving network resilience and applying innovative solutions such as flexible tariffs.

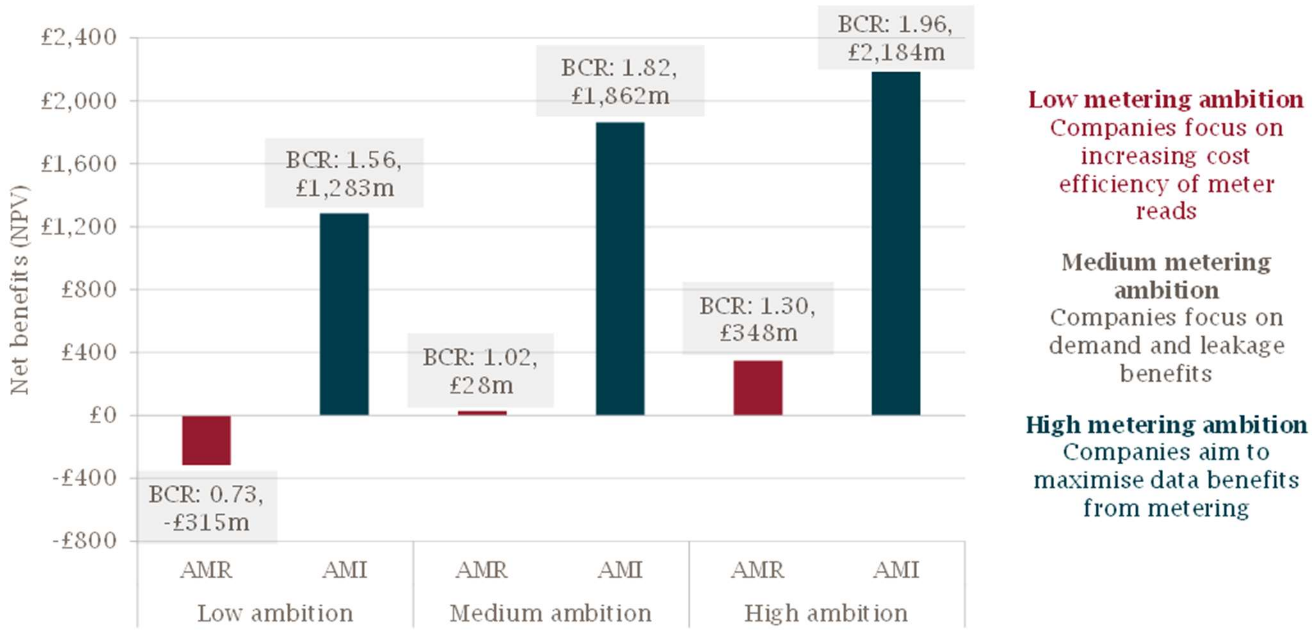
FIGURE 1 METERING AMBITION AND DATA BENEFITS



Source: Frontier / Artesia

Figure 2 shows the net benefits and benefit-cost ratios (BCR) of AMI and AMR under these three ambition scenarios. AMI delivers substantial additional benefits compared to AMR across all three:

FIGURE 2 AMI OUTPERFORMS AMR IN THE COST-BENEFIT ANALYSIS



Source: Frontier / Artesia analysis

Note: BCR stands for Benefit-Cost Ratio and represents the expected value of benefits per £1 of costs incurred. A BCR greater than 1 indicates higher benefits than costs, while a BCR below 1 indicates lower benefits than costs

As highlighted in our November 2021 report the benefits of AMI smart metering to water companies comes in the form of savings in other costs (e.g. cost savings on leakage control, network management and avoided costs of other water resources). As a result the programme would reduce the total costs incurred by water companies and this should be passed onto customers in the form of lower average bills for households.

Our analysis is conducted for England and Wales as a whole and we recognise that companies will be in different positions in terms of their own metering journey and the scale of their own challenges. Nevertheless, the additional benefits of AMI identified in this report clearly extend well beyond those simple related to future water resource management. The use of data from AMI can impact the way services are provided across the value chain and have the potential to transform how water companies interact with customers. Our first key recommendation is therefore directed at water companies, alongside a summary of benefits which water company management may enable through AMI:

Recommendation 1

Water companies

In the coming investment planning round companies should analyse their metering investment choices in a strategic and holistic way. These choices should align with a wider long-term strategy for engagement of all customers, integrating data from smart networks, and for unlocking the power of data across the business.

If you are responsible for…

Customers and demand	Achieving Net Zero	Asset management	Reducing leakage	Business and regulatory planning	Financial performance
AMI can help: ▪ Build a clear understanding of your customers and their consumption ▪ Engage effectively with customers and target interventions for vulnerable customers ▪ Improve efficiency of customer contact due to frequent and actionable data	AMI can help: ▪ Reduce energy consumption used in abstracting, treating and pumping water due to reduced consumption and leakage ▪ Improve energy efficiency of meter reading processes	AMI can help: ▪ Deliver early warnings of deteriorating network assets ▪ Better target mains replacements ▪ Build a more proactive approach to asset health management ▪ Identify any meter issues more quickly	AMI can help: ▪ Accurately monitor water balance and night use data ▪ Locate network and supply pipe leakage more efficiently, with shorter run times ▪ Build a better understanding of customer-side leakage	AMI can help: ▪ Build resilience to future resource challenges ▪ Enable adaptability and optionality in planning ▪ Achieve regulatory targets more cost effectively ▪ Avoid large and lumpy CAPEX in supply-side schemes.	AMI can help: ▪ Avoid large upfront capital cost for meters with a managed service approach ▪ Achieve leakage and consumption targets more cost effectively, and potentially enable outperformance ▪ Build optionality, rather than asset stranding risk

AMI AND ADAPTIVE PLANNING FOR AN UNCERTAIN FUTURE

The scale of the external challenges facing water companies are unprecedented. To meet these challenges the industry faces ambitious targets, water companies are planning to halve leakage levels by 2050 and Defra's Consultation on Environmental Targets issued in March 2022 proposes a 20% reduction in water usage per person by 2037. However, the impact of the external challenges remains uncertain. Ofwat therefore is challenging companies to develop long term strategies that are consistent with an adaptive planning framework[2]. Companies need to show how they are optimising the profile of their key interventions across time, ensuring that decisions are not avoided when they are needed – for example, to ensure resilience

[2] Ofwat, PR24 and beyond: Final guidance on long-term delivery strategies, April 2022

against high-impact scenarios – while minimising the risk of stranded assets should low impact scenarios come to pass. Our next findings are relevant in that context.

Finding 3 – The benefits of AMI investments are resilient to high impact future scenarios and AMI shows greater adaptability than AMR:

- If the challenges of climate change and demand growth are more severe than expected, then the comparative net-benefit of an AMI roll-out increases further compared to AMR. This reflects the underlying benefits in terms of data frequency and granularity which enable greater consumption and leakage benefits for AMI.

- AMI enables more optionality than AMR. The options to utilise the data and insights that AMI can provide are much harder or not possible to replicate under AMR.

Finding 4 – AMI is a "low regret" investment under an adaptive planning framework:

- The potential benefits from delaying investment appear to be small. First, the relatively short asset lives of metering infrastructure (for example, compared to the asset lives of other water projects such as reservoirs or pipelines) means delaying the investment in expectation of falling costs is a minor consideration.

- Second, companies may have a reason to delay investment if there were plausible future scenarios where the wider company strategy does not depend on the adoption of smart data technologies, particularly given the organisational time and effort required around staff, processes, systems and culture. However, in our view, these scenarios are very unlikely as data becomes an increasingly integral part of water company processes.

- On the other hand, the opportunity costs to delaying a decision to invest in AMI could be material. Our cost-benefit analysis shows that AMI delivers substantial positive net-benefits and more quickly than AMR.

- In addition, there is a growing body of experience of AMI and smart water data in England (across water companies and the supply chain) that other water companies can learn and benefit from. It is likely that best practice performance will be increasingly set by companies that have invested in smart technologies.

- Finally, the five year planning cycle means that a delay at this stage could push the rollout of AMI for some companies into the mid-2030s, increasing the risk of delivering against leakage targets or Defra's 20% consumption reduction target for 2037.

Therefore, our analysis indicates that there is no case to delay investment in AMI. This assessment leads to recommendations for companies and for Ofwat:

Recommendation 2

Water companies	**In applying the Adaptive Planning Framework to metering investment companies should account for the greater optionality that AMI provides relative to AMR. Companies should also recognise that the internal investment and reorganisation needed to achieve the benefits of AMI is likely to be part of a wider data strategy and therefore very unlikely to be a stranded cost.**

Recommendation 3

Water companies	Companies should also consider the risks of delaying a decision to invest in AMI and how this would affect their ability to deliver leakage and consumption reduction during the 2030s. Companies should consider that the use of the technology is becoming increasingly mature and is likely to define best practice performance in the sector.

Recommendation 4

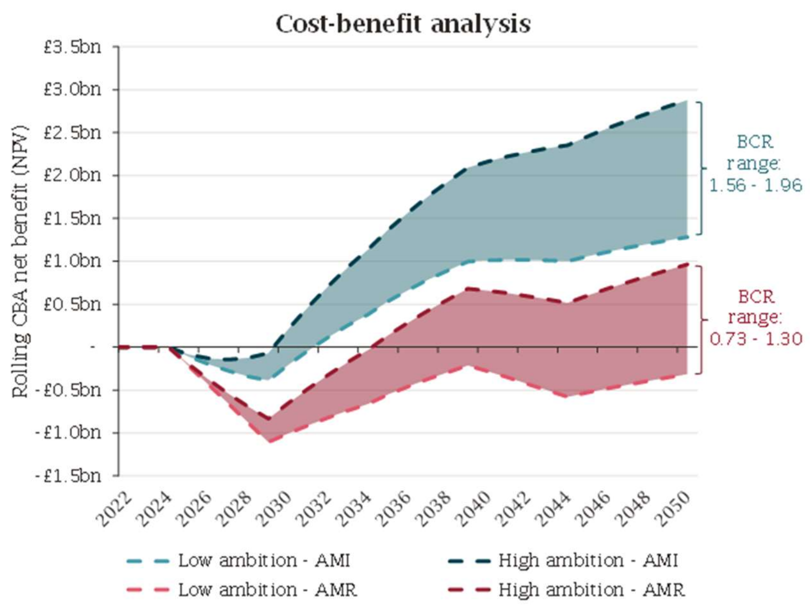
Ofwat	When assessing investment strategies for metering Ofwat should challenge companies on whether they have considered the full range of benefits metering options may enable. Ofwat should recognise that the full benefits of AMI involves wider investment and reorganisation in company processes. Ofwat should recognise that the benefits develop over time and ensure that the assessment of business plans does not favour short-term options. If a case is made to delay investment in AMI Ofwat should challenge companies that they have considered the additional optionality of AMI and the ‘low regret’ nature of the investment.

Summary of analysis

Our findings in this report are based on the expected costs and benefits of AMI and AMR metering roll-outs across England and Wales, alongside a qualitative assessment of other key benefits assessed from the perspective of both water companies and their customers.

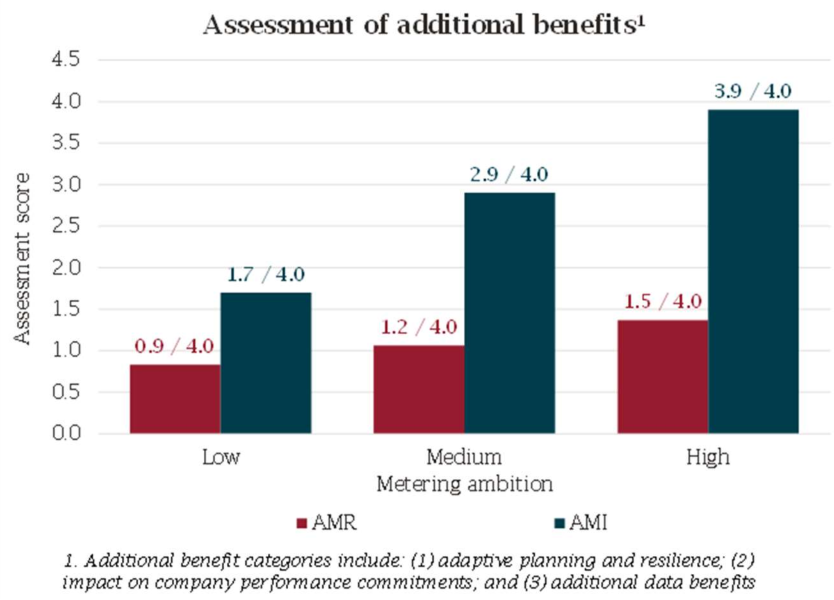
For the qualitative assessment of additional benefits, we focus on adaptive planning and resilience; impact on company performance commitments; and additional data benefits for customers. AMI and AMR are then scored on a 0 to 4 scale for additional benefits, with 0 representing no benefits and 4 representing maximum benefits.

FIGURE 1 AMI OUTPERFORMS AMR IN THE COST-BENEFIT ANALYSIS OVER TIME...



Source: Frontier / Artesia analysis

FIGURE 2 ... WHILE ALSO SCORING HIGHER THAN AMR FOR ADDITIONAL BENEFITS



Source: Frontier / Artesia assessment of additional benefits

1 INTRODUCTION

1.1 AIM OF THIS REPORT

Metering water usage unlocks data benefits for customers, water companies and wider society by encouraging consumption reduction, improving the accuracy and fairness of bills, helping detect leaks and enabling wider societal and service-related benefits. There are a number of different metering technologies which enable benefits from data, such as Advanced Metering Infrastructure (AMI), Automated Meter Reading (AMR) and manual "dumb" metering. Each technology has different data capabilities, costs and benefits. Companies will need to make decisions around metering at PR24 and these decisions will be important, as they lock them into a path for the next 15 years[3]. This multi-AMP commitment reflects the need for water companies to choose a metering approach that is not only future-proof but also builds optionality rather than barriers. The aim of this paper is to evaluate the different technologies – specifically AMI compared to AMR – to help explain the metering investment decision for water companies as they develop their plans for PR24.

In this paper, we analyse the quantitative costs and benefits of AMI and AMR meters alongside an analysis of key additional factors. Using a cost-benefit analysis, we compare roll-outs of both meters technologies over AMP8 and accounts for different levels of metering and data ambition achievable by water companies, given the different data capabilities of AMI and AMR. This cost-benefit analysis builds on our 2021 analysis for Arqiva[4], where we analysed the costs and benefits of an Advanced Metering Infrastructure (AMI) roll-out across England and Wales by 2030. The 2021 analysis highlighted the high levels of net benefits for AMI and supported the case for an accelerated roll-out of smart metering across England and Wales.

The results from this paper's cost-benefit analysis show that AMI metering programmes are expected to be more beneficial than AMR metering programme at all levels of ambition, with c. £1.3bn to £2.2bn in net benefits expected from AMI. AMR roll-outs are nonetheless expected to be beneficial given adequate amounts of ambition, but are only expected to achieve c. £30m to £0.4bn in net benefits for medium to high levels of ambition. At low levels of ambition, where metering programmes are primarily focussed on improving cost efficiency compared to BAU, a similar roll-out of AMR technology is not expected to be cost beneficial with c. -£0.3bn in expected net benefits.

In addition to the headline CBA, we also explored the resilience of AMI and AMR technology in light of more challenging future circumstances. We applied principles from Ofwat's latest guidance on long-term planning and evaluating investments at PR24[5] by analysing the impacts of high climate change and demand scenarios. The results of this analysis show that the benefits of AMI investments are more resilient to high-impact external scenarios, with an increasing gap between the net benefits of AMI approaches compared to AMR.

A third area we explored was the impact AMI or AMR metering may have on companies' regulatory performance commitments ("PCs"). PCs relate to key service areas that companies have to achieve baseline levels of performance against, or risk being penalised financially for under-delivery. Leading companies are also rewarded for out-performance. Our analysis of key performance commitments shows that AMI's data capabilities allow it to unlock higher performance than AMR, giving companies more potential to achieve

[3] 15 years is the average asset life of a water meter

[4] Frontier Economics and Artesia, Report: Cost benefit analysis of water smart metering, November 2021

[5] Ofwat, PR24 and beyond: Final guidance on long-term delivery strategies, April 2022

outperformance relative to similar companies without AMI meters within any given regulatory price control period.

The final aspect of metering we examined was potential additional data benefits achievable through AMI and AMR. As long-term investments, companies need to consider both immediate and potential benefits of metering technologies. Benefits derived from metering fundamentally depend on the quality and quantity of data gathered from meters, and AMI's ability to deliver frequent and detailed data opens a wider set of potential benefits compared to AMR. These include better support for vulnerable customers, wider water network spill-overs, innovative and flexible tariffs and the use of nudges to deliver behaviour change. All of these further benefits depend on high levels of data frequency and granularity, which can only be delivered by AMI meters.

Overall, our analysis points to a strong positive case for timely investment in AMI metering technology. The water sector faces numerous challenges and targets over the coming AMPs, such as increasing pressure on water resources from climate change and ambitious leakage targets as per the recent Water UK Leakage Routemap[6]. These challenges will need to be squared with concerns around the cost of living crisis and affordability. Defra's Strategic Policy Statement for Ofwat states that water companies are expected to *"plan, invest in, and operate its water and wastewater services to secure the needs of current and future customers, in a way which delivers value to customers, the environment and wider society over the long-term"*[7]. Our findings show that AMI represents a "low-regret" investment. This is because AMI is more cost effective than AMR in achieving consumption reduction, leakage efficiency and carbon abatements, while also being a resilient option in light of potential climate and demand challenges in the future. AMI is also expected to achieve positive net-benefits more quickly across a meter's life-cycle than AMR, reducing the risk that customers will pay for assets that become stranded from any later changes in circumstance or strategy.

1.2 STRUCTURE OF THIS REPORT

This report is structured as follows:

- Section 2 reviews the role of metering and data to achieve long-term objectives for the water sector
- Section 3 presents our evaluation of metering options, using cost-benefit analysis, scenario analysis, impact analysis on performance commitments and evaluation of additional data benefits
- Section 4 summarises the implications of our analysis for water companies and Ofwat
- Annex A provides more detail on our evaluation methodology
- Annex B provides more detail on our Multi-Criteria Decision Analysis methodology for additional benefits

[6] Water UK, A Leakage Routemap to 2050, 2022

[7] Defra, The government's strategic priorities for Ofwat, February 2022

2 THE ROLE OF METERING AND DATA TO ACHIEVE LONG-TERM OBJECTIVES FOR THE WATER SECTOR

2.1 LONG-TERM TARGETS FOR THE WATER INDUSTRY

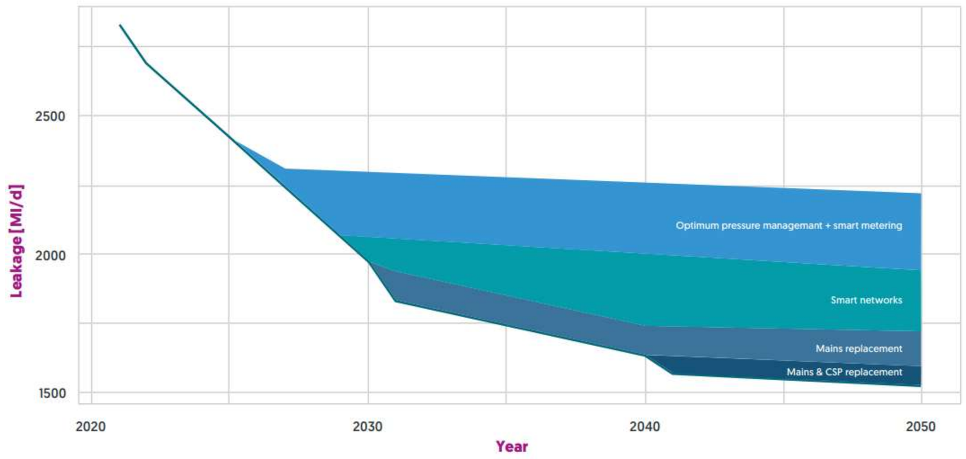
The UK water sector faces a number of significant challenges in providing sufficient water to meet the future needs of people and industry, whilst also taking care of the environment. Increasing population and climate change will lead to increased demand, and less predictable precipitation because of climate change will affect the environment and limit the water available for abstraction. Together these create challenges in balancing supply and demand, and impact resilience to short term or unpredictable events.

Water UK has set out a Vision for 2050[8] which identifies five key challenges:

- The climate emergency - the risk of increased water scarcity and the industry has committed to cutting operational carbon emissions to net zero this decade.
- Population growth.
- Future-proofing asset health and skills.
- Increased environmental standards underpinned by societal expectations.
- Increased customer, community and societal demands.

Companies and Water UK have also developed Public Interest Commitment Route-maps for Net Zero[9] and reducing leakage from pipes[10]. The leakage route map sets targets for trebling the rate of leak reduction by 2030 halving leakage by 2050, through smart networks and adaptive plans to use innovation and technology to locate and repair leaks more efficiently and effectively, and to increase the health of pipe assets. Figure 3 shows a summary from the route map of the ambition and approaches for reducing leakage.

FIGURE 3 WATER UK LEAKAGE ROUTE MAP SUMMARY



Source: Water UK, A Leakage Routemap to 2050, March 2022

[8] Water UK, Developing a 2050 Vision for the Water Sector: A Discussion Paper, March 2021

[9] Water UK, Net Zero 2030 Routemap, November 2020

[10] Water UK, A Leakage Routemap to 2050, March 2022

There are additional drivers for reducing demand from the EA National Framework for Water Resources, which states household consumption needs to fall by 110 l/p/d by 2050 – a 20-25% reduction[11]. Respective water company WRMP's are built around this target. Nicci Russell, chair of the Senior Water Demand Reduction Group (SWDRG), wrote an open letter in December 2021, advising the overall distribution input (DI) target should be more ambitious than the equivalent 2037 version of the National Framework target (of 110 l/p/d by 2050)[12]. The letter recommends a statutory DI percentage reduction target. Defra's Consultation on Environmental Targets issued 16th March 2022 proposes a 20% reduction in Distribution Input per head by 2037.

There are also calls for water companies to understand the needs of their customers through better engagement and the use of data when developing their longer-term outcomes and priorities. Defra has stated that water companies should place *"greater focus on better customer engagement and the use of data to improve efficiency and effectiveness"* and that company plans should reflect evidence of customers' expectations, and the affordability and acceptability of future bills[13].

2.2 INVESTING IN THE CORRECT METERING APPROACH IS IMPORTANT

As the next round of investment planning approaches, water companies are faced with a critical choice. This choice, at its most basic, is about the type of water meters the companies install for billing purposes. Companies may then assume that choosing the lowest cost solution which enables this charging to take place, but metering is also one of the few multi-benefit solutions available to water companies which:

- Drives improvements in key areas such as consumption and leakage;
- Allows better network monitoring;
- Enables cost efficiencies; and
- Fosters better customer engagement.

But the decisions that companies make around metering will be important, as they lock them into a path for the next 15 years[14]. This multi-AMP commitment reflects the need for water companies to choose a metering approach that is not only future-proof but also builds optionality rather than barriers. Defra's SPS for Ofwat emphasises the need for efficient investment which "secures long-term resilience and protects and enhances the environment, whilst delivering value for money for customers, society and the environment over the long-term"[15].

Companies will need to ensure that their decision between different metering technologies is resilient and creates choices for the future. A "wrong" decision would be costly and difficult to change, and companies would need to play catch-up in 15 years' time.

[11] Environment Agency, National Framework for Water Resources, March 2020

[12] SWDRG, Advice from Chair of the Senior Water Demand Reduction Group, December 2021

[13] Defra, Consultation on environmental targets, March 2022

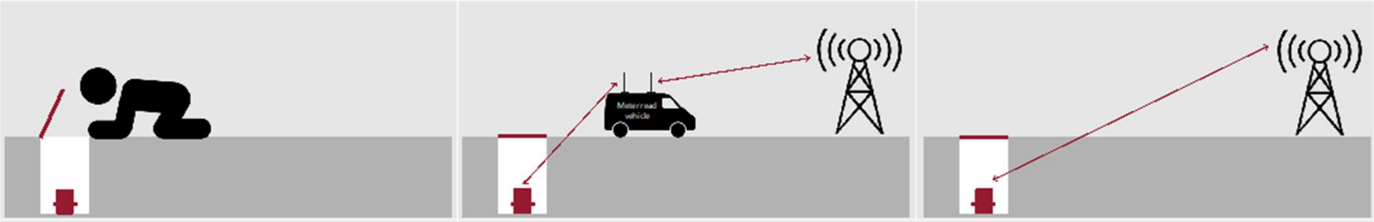
[14] 15 years is the average asset life of a water meter

[15] Defra, The government's strategic priorities for Ofwat, February 2022

2.3 OPTIONS FOR WATER METERING

Metering generally is seen as the fairest way to pay for water services[16] and overall, there are three broad choices for metering available to companies, as described in Figure 4 below.

FIGURE 4 THREE OPTIONS FOR METERING



'Dumb' manual read	Automatic meter reading (AMR)	Advanced meter infrastructure (AMI)

▪ Mechanical meter with volumetric register
▪ Requires access to the meter chamber and a visual read
▪ Visual read is transcribed to a mobile device
▪ Data uploaded to a meter database
	▪ Automatic Meter Reading via a vehicle driving (or person walking) past every meter
	▪ Two variants:
	  ▪ Uni-directional where the meter 'pings' a register value continuously and the AMR picks up this value
	  ▪ Bi-direction where the meter stores values in a memory, the AMR device wakes up the meter and data is transferred
	▪ Data is uploaded from the AMR device to a meter database
		▪ Advanced Meter Infrastructure reading via a fixed wireless network
		▪ Meter stores data (meter reads, diagnostic information, alarms, etc) in memory and send data over the fixed network
		▪ Typical data granularity is hourly (or every 15-minutes)
		▪ All meters typically transfer data multiple times per day to the meter database

Source: Frontier / Artesia research

Manual read or 'Dumb' meters

Manual read or dumb meters are assumed to be a mechanical meter with a visual register. Meter reading is done manually via a meter reading operative accessing the meter, reading the meter register and entering this information onto a device. Data is then uploaded to a meter read database. Readings are collected twice a year, providing a minimum of a rolling annual consumption value.

Automated Meter Reading (AMR)

We define automated meter reading (AMR) as a drive-by meter reading system, where meter reads are collected by driving past the meters and automatically picking up consumption data from the meters via short range radio, meter readings are then uploaded from the drive by device to the utility. To minimise drive-by runs and maximise data collection, bi-directional drive-by technology is assumed (i.e. the drive-by device sends a wake-up call to the meter, and then the meter sends its stored data to the drive-by device).

The assumptions are that data from each meter is collected twice per year, and that weekly consumption data is collected along with leak alarm status data. This means that a minimum of 26 data points (plus alarm status) are downloaded from each meter at every drive-by. Data is then directly uploaded to a meter management database (either a 3rd party or utility system) and then data is integrated into other utility

[16] CIWEM, Water efficiency in the home, August 2015

systems such as billing. Meter drive-by could be carried out by the utility, a 3rd party meter reading organisation or via an alternative means such as the refuse truck solution used by United Utilities[17].

Specifically, in this study AMR is being applied to "full" metering scenarios defined as 80% or more. However, such levels of AMR metering is not currently done in the UK. Therefore, in the modelling it is assumed that there is a 70% success rate of data collection, and additional drive-by runs are carried out to capture a data collection rate of 95%.

Advanced Metering Infrastructure (AMI)

For the purposes of this report, we define smart meters to be Advanced Metering Infrastructure (AMI) where hourly meter data is transmitted daily via a fixed network to the utility. More specifically, the water smart meters in this report are assumed to be Sensus meters connected to an Arqiva radio fixed network.

The fixed network 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 provide 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.

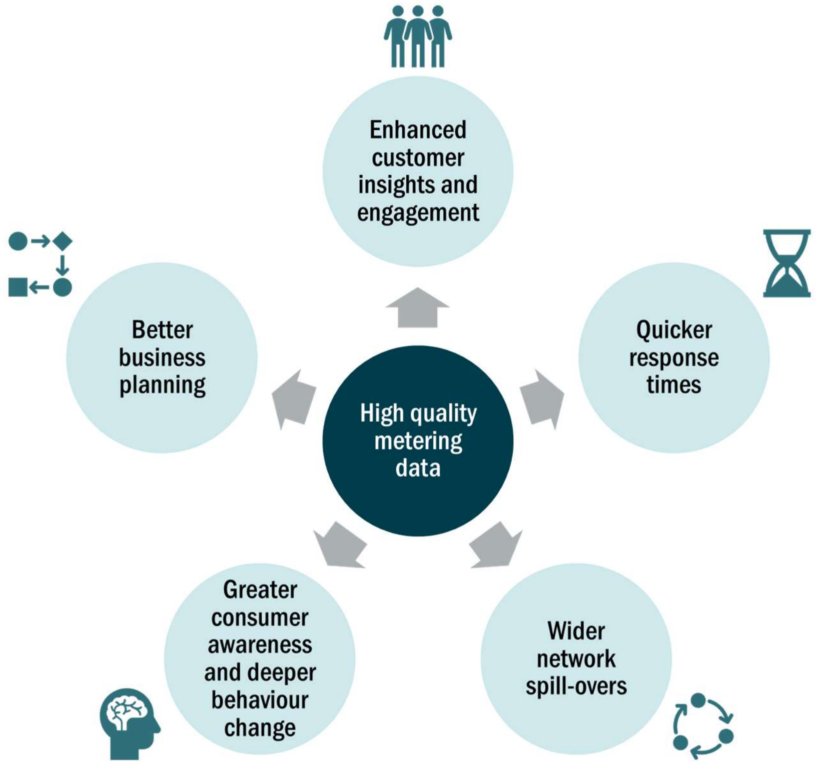
Data collected at the base station is relayed securely to Arqiva-owned and operated data centres. From this point, the data is passed on securely to the water company meter data management system to use for billing, for providing data to customers and for analysis. The system can provide hourly or 15-minute 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, and so includes for the replacement of faulty meters.

2.4 IMPORTANCE OF DATA TO UNLOCK METERING BENEFITS

For metering, the key choice or decision is commonly perceived to be "which technology to select"? However, the technology is the means to an end, and it is the data provided by the technology which allows utilities and customers to unlock the benefits of metering. Good quality and granular data are essential for unlocking consumption, leakage and customer benefits. For instance, hourly consumption data allows the utility to identify water consumption which is due to water using practices or activities, and identify continuous flows which could be due to leaks or wastage from appliances. This in turns allows utilities to prioritise their response to potential water wastage and support particular groups of customers. This increases efficiency and improves customer service.

[17] United Utilities, Automated Meter Readers, webpage

FIGURE 5 BENEFITS OF HIGH QUALITY METERING DATA



Source: Frontier / Artesia visualisation

Metering technologies can however lend themselves to different levels and quality of data, due to factors such as read frequency, granularity and other data features. Figure 6 below lists some key data characteristics for dumb, AMR and AMI metering approaches, based on assumed data capabilities achievable at "full" metering with 80% penetration.

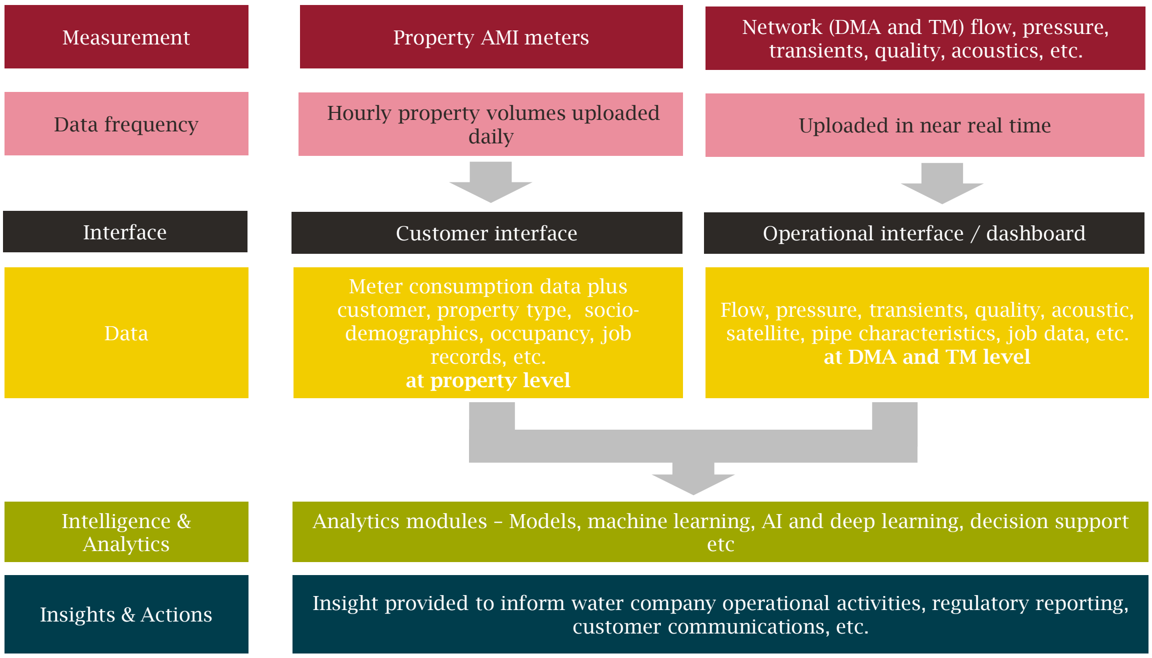
FIGURE 6 METERING TECHNOLOGY AND DATA CHARACTERISTICS

	Dumb	AMR	AMI
Read frequency	Twice a year (visual read)	Twice a year (drive by)	Hourly reads
Data granularity	Annual consumption (billing requirement)	Weekly consumption data	Hourly consumption data
Continuous flow data	None	Leak alarm	Based on consumption profile + adjustable leak alarm
Data completeness per read	C. 75% (additional reads needed to reach required level of 95%)	C. 70% (additional reads needed to reach required level of 95%)	99.95% (Arqiva SLA)
Data security / risk	Prone to errors in visual reads and entering data	Higher risk than AMI - Security should be enabled	End to end encryption and ability to update security remotely

Source: Frontier / Artesia, based on publicly available information, information on AMI meters provided by Arqiva and expert judgement.

Due to advantages across all the meter characteristics, AMI can build more complete and frequent datasets which in turn enable greater levels of benefits. This will be explore further in the evaluation of AMI and AMR in section 3 below. An additional benefit of AMI data capabilities is the ability to integrate meter data with network data to improve network operations and increase leakage efficiency. Figure 7 illustrates how property level, customer and network data can be combined to deliver actionable insights for the utility, and provide customers access to data to help them manage their own water use more effectively.

FIGURE 7 USING AMI AND NETWORK MONITORING FOR ACTIONABLE INSIGHT AND OUTCOMES



Source: Frontier / Artesia

CASE STUDY

Watersmart and automated leak detection and resolution solutions from the USA

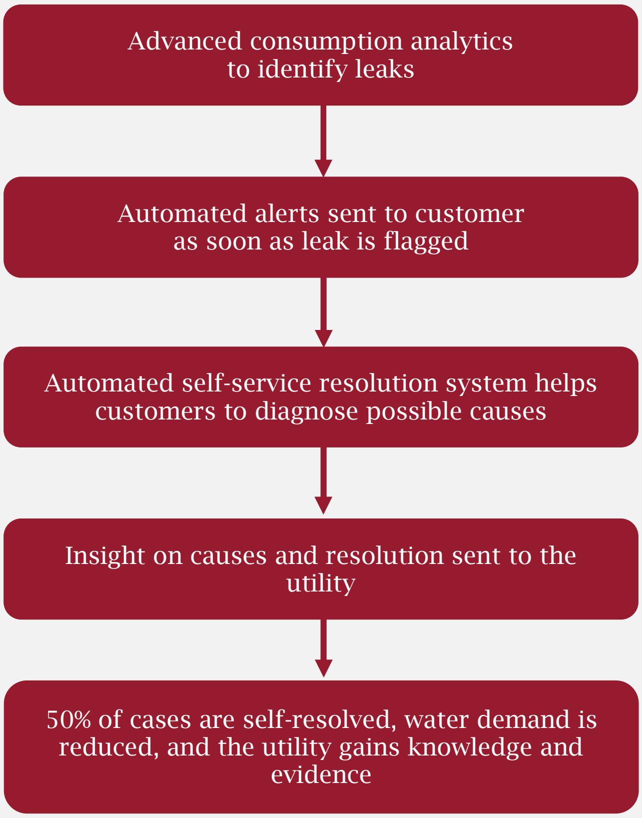
Watersmart[18] offer a service (largely in the USA) based around a customer engagement and data analytics platform to help water utilities reduce the cost to serve their customers, improve operational efficiency, and increase customer satisfaction.

As part of this service, they have implemented a customer application to help customer resolve water consumption wastage, whilst provide valuable information back to the water utility.

Using this system potential wastage or leakage is automatically detected with consumption analytics, these generate automated alerts. The alerts trigger an automated self-service resolution system that helps the customer diagnose possible causes of the leakage or wastage.

During this process the utility also gets sent vital information on the potential cause of the issue and whether the customer was able to resolve the issue. They have found that 50% or more of customers resolve the problem, with a satisfaction rating of 97%.

The added benefit for the utility is that it also reduces their work-load, by automating much of the processes.



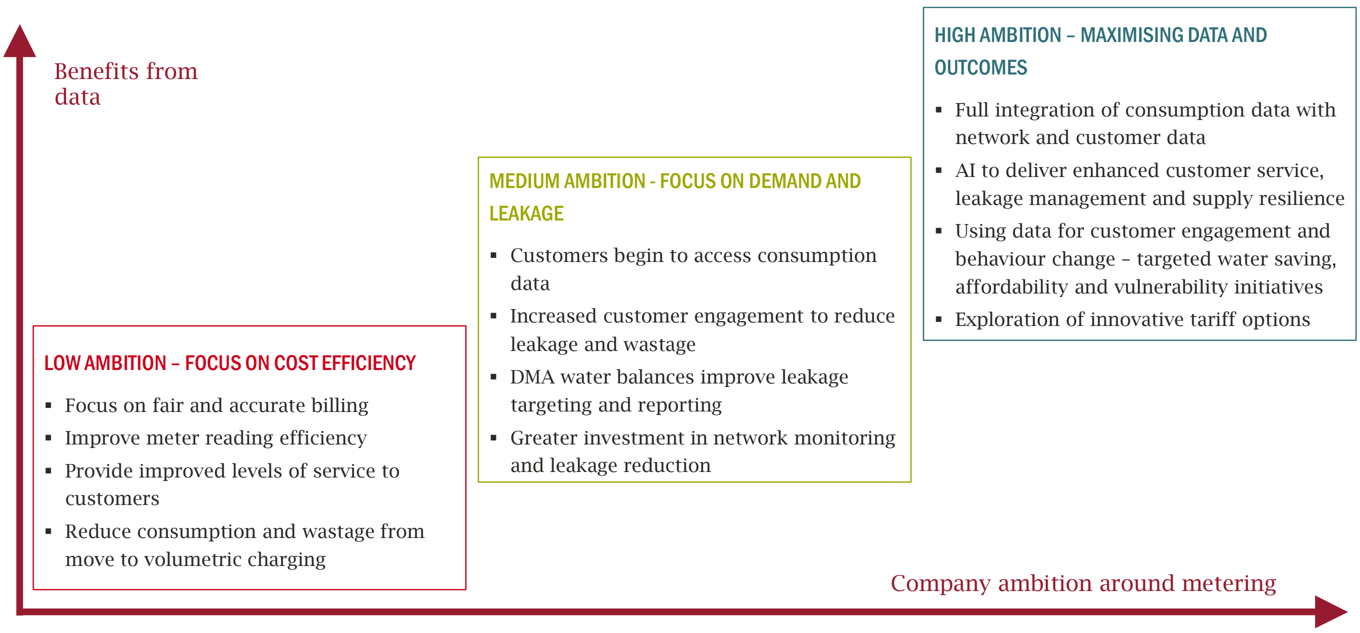
2.5 COMPANIES' LEVELS OF AMBITION WILL DETERMINE THEIR BENEFITS FROM DATA

As discussed above, choices around metering technology will generally determine the quality and quantity of data used to delivery benefits for customers. But companies also have a role to play, and the ambition by which they approach their metering programmes will determine short and long-term outcomes.

Characterisation of different ambitions and priorities is shown in Figure 8 below, based on three levels of ambition that water companies may aspire to depending on their specific requirements.

[18] Watersmart, Tapping into a new resource management technique: Automated leak detection and resolution solutions, webpage

FIGURE 8 METERING AMBITION AND DATA BENEFITS



Source: Frontier / Artesia

- **Low ambition:** At the lowest level of ambition, data benefits will be minimal as the focus of metering programmes will be to increase meter read cost efficiency, relative to BAU costs. But due to improved billing and accuracy, some incremental consumption reduction can also be expected at this initial level of ambition.

- **Medium ambition:** A higher level of metering ambition moves companies' focus to using data to unlock consumption and leakage benefits. Companies also begin to use data to engage further with customers around their consumption, alongside using network data to better manage leakage.

- **High ambition**: Companies begin to fully utilise the power of data and insights from metering to deliver customer outcomes and resilient services. This would involve the integration of consumer insight from metering into BAU processes, improving network resilience and applying innovative solutions such as flexible tariffs.

Companies will need to determine what level of metering and data ambition they believe is most effective in achieving their long-term goals, while also being mindful of costs and organisational change. Higher levels of ambition will naturally lend themselves to better outcomes, but also entail employee time and costs of upgrading processes and back-office systems. A lower level of ambition will not result in as many data benefits being extracted from metering, but will result in lower costs and will be easier to achieve without much organisational change.

While companies will be able to adjust their metering programmes depending on their internal levels of ambition, a key consideration will nevertheless be the choice of metering technology. Water companies will need to consider whether the selected meter technology is able to deliver the correct levels of data in the required frequency to act upon customer, leakage and other insights. As discussed in section 2.4, AMI and AMR are both able to provide more accurate data than dumb meters. However, a key difference between AMI and AMR is the much higher level of meter read frequency and greater levels of data granularity delivered by AMI. This will in turn determine the levels of benefit delivered to companies and customers by AMI or AMR metering approaches for a given level of ambition.

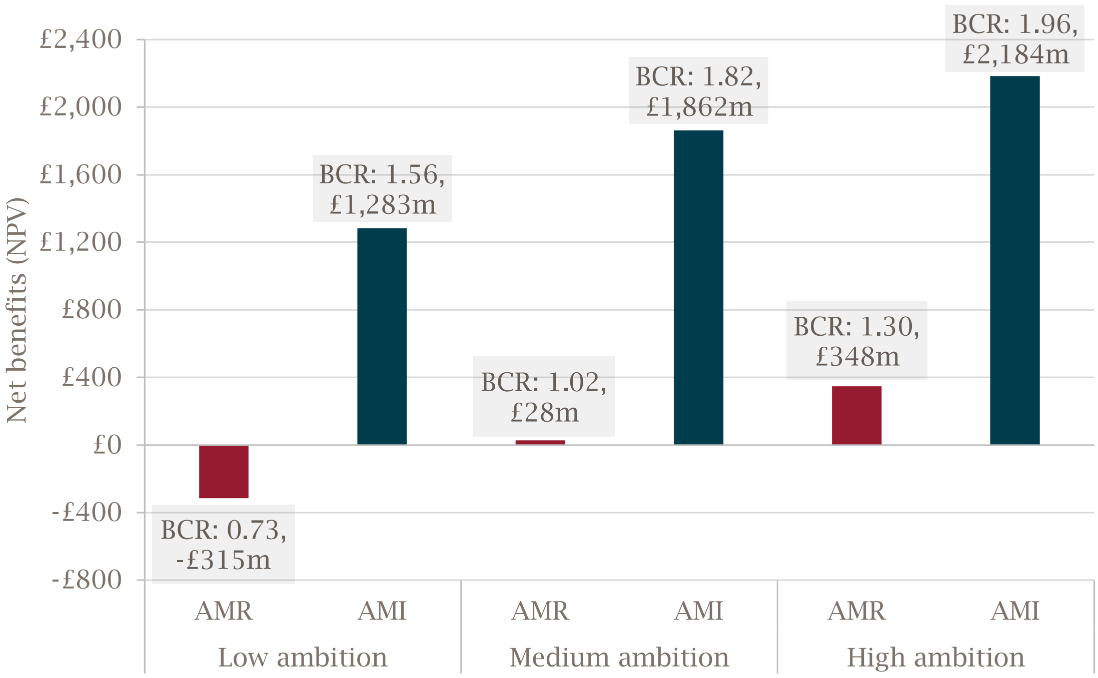
3 EVALUATION OF METER OPTIONS[19]

3.1 COST-BENEFIT ANALYSIS: AMI EXHIBITS SIGNIFICANTLY HIGHER NET BENEFITS COMPARED TO AMR

Our cost-benefit analysis shows that AMI approaches are expected to be significantly more cost-beneficial than AMR, across all levels of ambition. This is primarily due to AMI's strengths in data, with high levels of read frequency and data granularity that maximise benefits from consumption reduction and leakage efficiency relative to the more data-constrained AMR. Figure 9 below presents the results of the CBA across the three levels of ambition.

AMR is not expected to deliver as high benefits due to constraints around read frequency and data granularity at 80% meter penetration, which limits benefits from consumption reduction and leakage efficiency. The medium ambition AMI results remain similar to the headline CBA results from our 2021 study[20], with a slightly higher BCR[21] of 1.82 compared to 1.73 previously. The main differences between these results are related to updates to the methodology, such as the use of updated BEIS carbon values, adjustment to BAU meter benefits and the exclusion of Thames and Anglian from the underlying data[22].

FIGURE 9 AMI OUTPERFORMS AMR IN THE COST-BENEFIT ANALYSIS



---

[19] Further detail on the methodology underpinning our evaluation can be found in Annex A.

[20] Frontier Economics and Artesia, Report: Cost benefit analysis of water smart metering, November 2021

[21] BCR stands for Benefit-Cost Ratio and represents the expected value of benefits per £1 of costs incurred. A BCR greater than 1 indicates higher benefits than costs, while a BCR below 1 indicates lower benefits than costs.

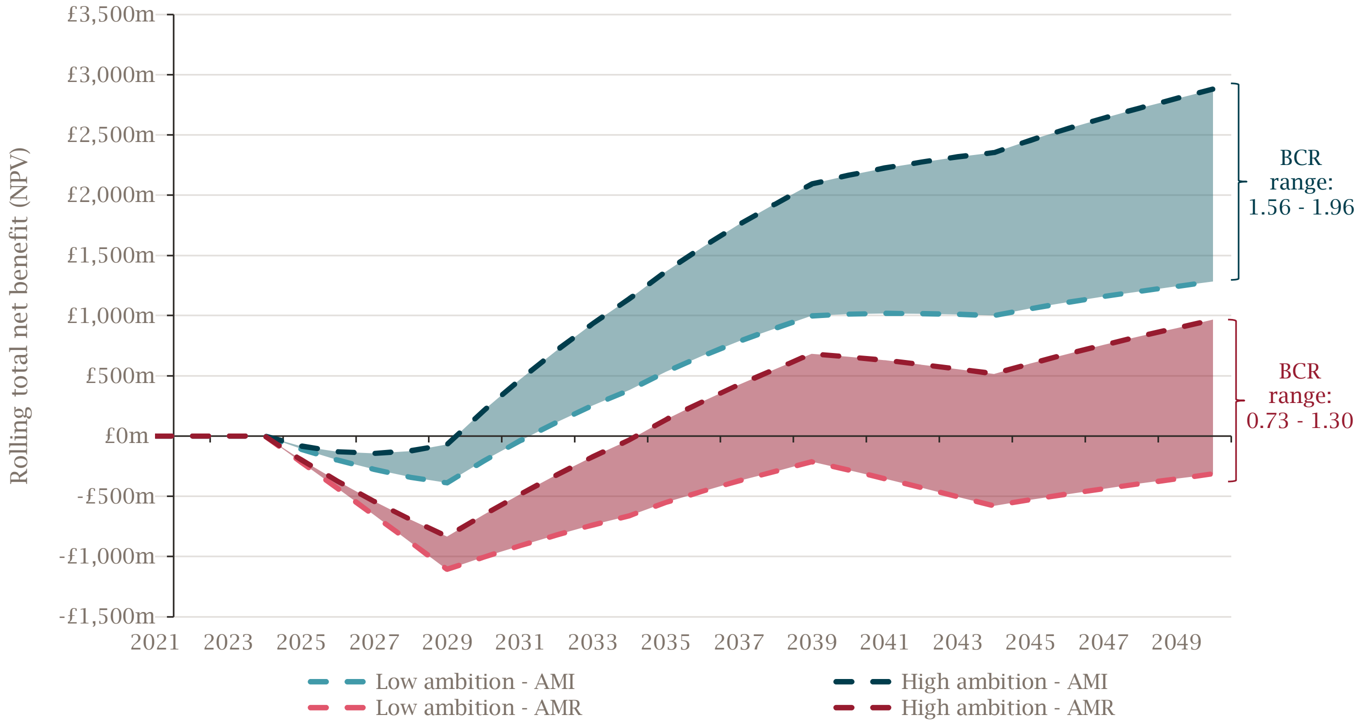
[22] We exclude Anglian and Thames' data as both companies have already rolled out AMI meters as part of their BAU plans. Including them in the sample would reduce the intuitiveness of results, as the CBA analysis is based on a comparison of an AMI or AMR roll-out to the BAU counterfactual for each company, which in the cases of Anglian and Thames is already AMI-based.

Source: Frontier / Artesia analysis

Note: BCR stands for Benefit-Cost Ratio and represents the expected value of benefits per £1 of costs incurred. A BCR greater than 1 indicates higher benefits than costs, while a BCR below 1 indicates lower benefits than costs

The AMI approach is also expected to be cost-beneficial more quickly than AMR, with positive cumulative net benefits as early as 2029 for AMI compared to 2035 for AMR. This is due to AMI's higher data benefits accruing sooner, as well as due to benefits from smoothing meter acquisition costs based on the managed service approach modelled for AMI, which is not currently available for AMR. Timing of benefits are an important consideration given the high levels of investment required to undertake a metering programme which targets 80% penetration. AMI's larger data benefits also ensure that net benefits don't fall during the second roll-out of meters during 2040 – 2045, following the 15 year asset life of the initial meter roll-out in AMP8. Conversely, due to its lower data benefits, AMR's net benefits fall during the second roll-out as meter replacement and installation costs outweigh benefits from metering over the period.

FIGURE 10 ROLLING TOTAL NET BENEFIT RANGES OVER TIME



Source: Frontier / Artesia analysis

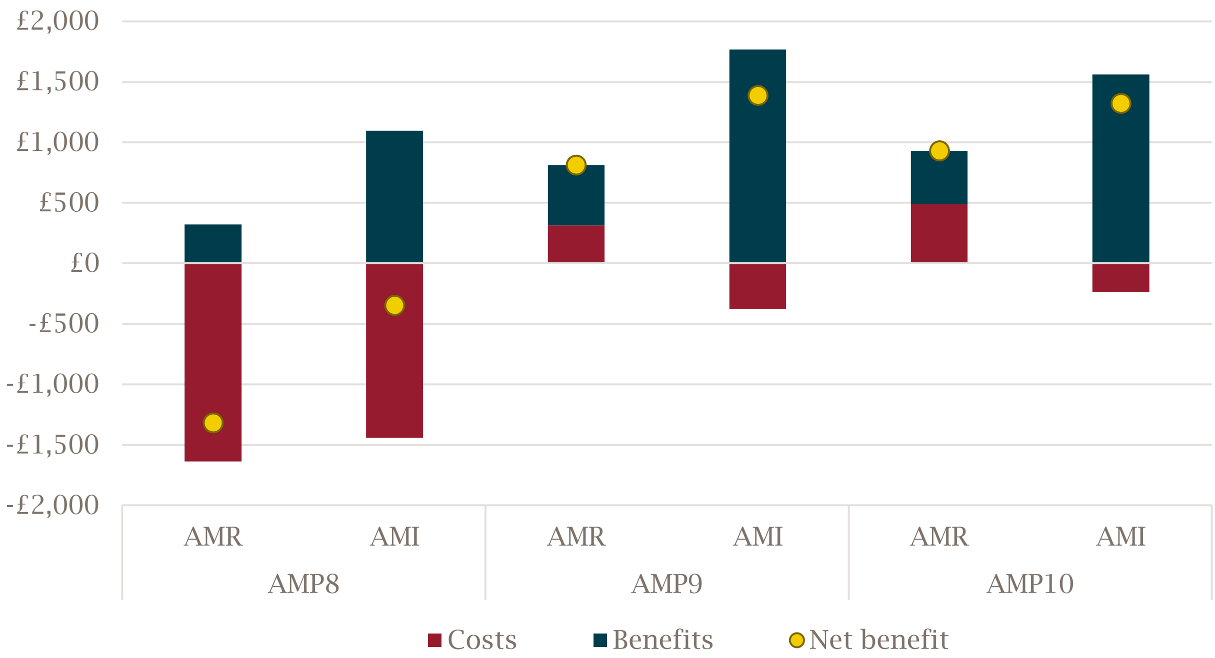
Note: BCR stands for Benefit-Cost Ratio and represents the expected value of benefits per £1 of costs incurred. A BCR greater than 1 indicates higher benefits than costs, while a BCR below 1 indicates lower benefits than costs

Both metering options would require significant investment outlays over the AMP8 period, as a roll-out targeting 80% penetration will involve costs for meter acquisition, installation and back-office costs. However, AMI is expected to have a much higher net benefit compared to AMR in AMP8, due to higher consumption and leakage benefits as well as cashflow benefits of meter acquisition costs under a managed service contract. Over the next two AMP periods, both technologies experience lower costs[23] as no further installation costs and back office investments are required until the end of the 15 year asset life. AMI is modelled to have some ongoing incremental costs compared to BAU due to network management costs and

[23] AMR is expected to have negative incremental costs compared to the BAU counterfactual, as the modelled replacement of legacy meters in AMP8 brings forward meter replacement costs which would otherwise have been incurred in AMP9 and 10

higher back office costs, but AMI also enables much greater benefits which result in higher overall net benefits compared to AMR over AMPs 9 and 10.

FIGURE 11 METER COSTS AND BENEFITS OVER THE NEXT THREE AMPS



Source: Frontier / Artesia analysis
Note: Results presented under the medium ambition metering scenarios

Companies may still consider delaying investment in AMI if they believe there are benefits to postponing investment. However, any potential benefits from delaying investment appear to be small in our view:

- First, the relatively short asset lives of metering infrastructure (for example, compared to the asset lives of other water projects such as reservoirs or pipelines) means delaying the investment in expectation of falling costs is a minor factor.

- Second, if there were plausible future scenarios where companies did not need to adopt smart data technologies more generally, companies may have a reason to delay investment given the organisational time and effort required around staff, processes, systems and culture. However, in our view these scenarios are very unlikely as data becomes an increasingly integral part of water company processes.

- Lastly, there is a growing body of experience of AMI and smart water data in England (across water companies and the supply chain) that other water companies can learn and benefit from. It is likely that best practice performance will be increasingly set by companies that have invested in smart technologies.

Therefore, our analysis indicates that there is no case to delay investment in AMI.

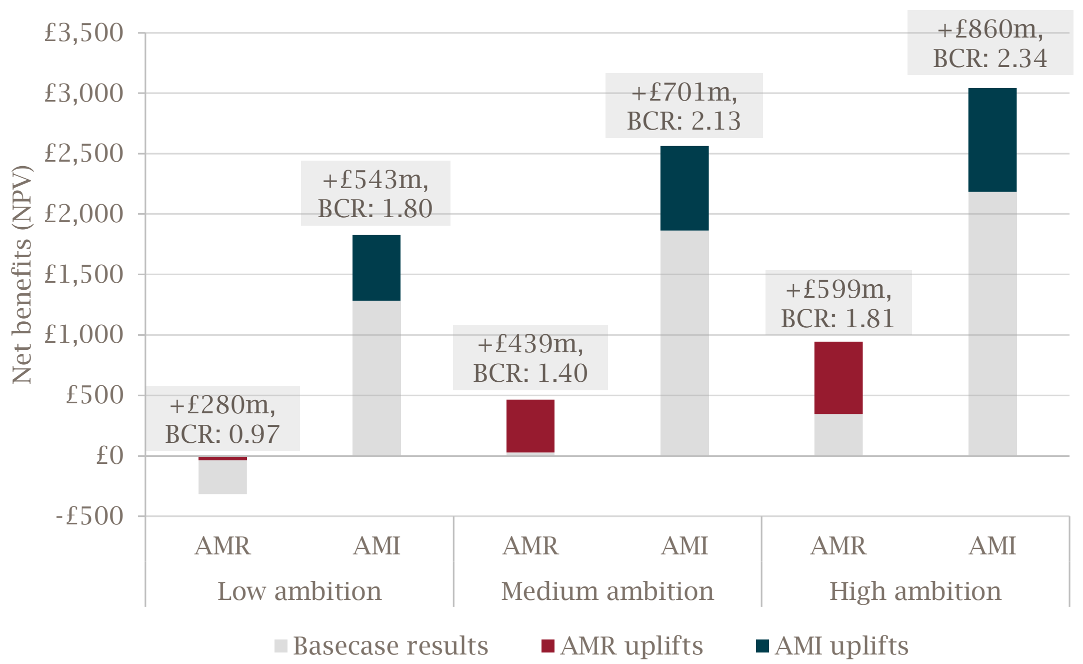
The key finding from the cost-benefit analysis is that AMI's data capabilities can enable much more for companies at all levels of ambition, and therefore deliver higher benefits for customers than AMR. These CBA results also point to AMI having the attributes of a "low regret" investment, as AMI is expected to achieve positive net-benefits more quickly across the meter's life-cycle than AMR and the likelihood of benefits from delaying investment are low.

3.2 ADAPTIVE PLANNING: AMI APPROACHES ARE MORE RESILIENT TO ADVERSE FUTURE SCENARIOS

Water companies face high levels of risk to service from climate change, as a warmer climate and more frequent extreme weather events impact water resources and customer demand. To incorporate principles from Ofwat's PR24 high climate change scenario[24], we applied a "high" value on carbon emissions based on BEIS' published carbon values for policy appraisal and evaluation[25]. This is compared to the more conservative modelling approach applied in the headline CBA, where a low carbon value is applied.

Overall, AMI is expected to be more resilient and deliver higher benefits compared to AMR in a high climate scenario. As in the headline CBA, this is due to AMI's higher consumption reduction benefits which include the modelled ability to reduce peak consumption in addition to base consumption. The results of the high climate change scenario are presented in Figure 12 below. The higher carbon value improves the net benefits across all ambition levels and metering technologies as carbon abatements from metering become more valuable to society, although low ambition AMR remains net negative.

FIGURE 12 ADVERSE CLIMATE SCENARIO RESULTS



[24] More detail on our application of principles of Ofwat's PR24 reference scenarios are explained in Annex A.4

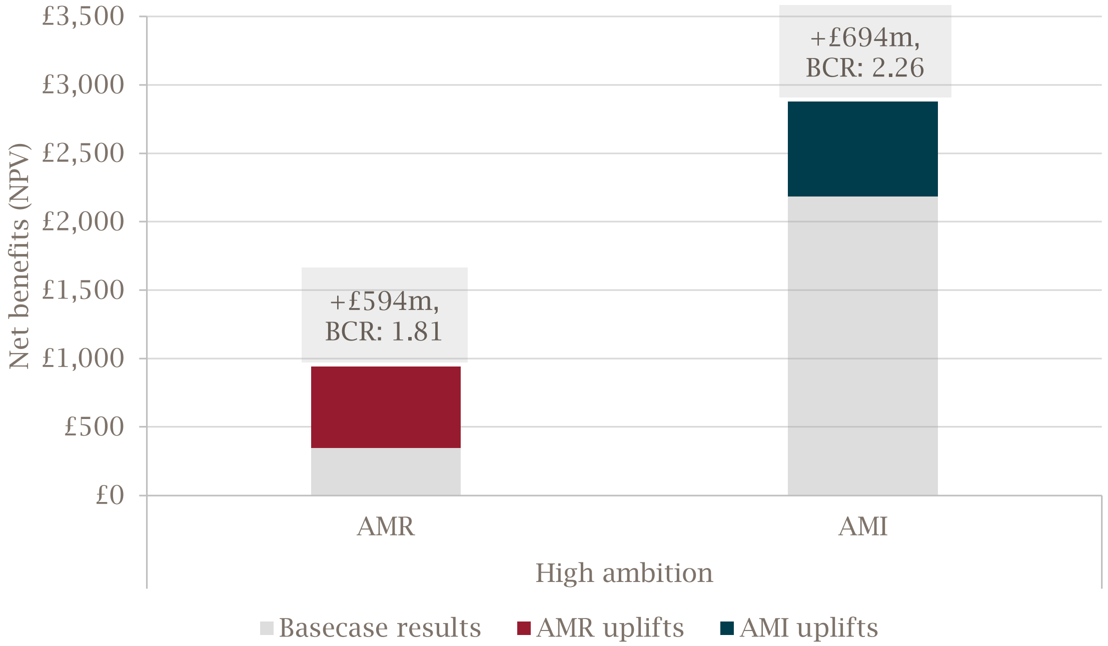
[25] BEIS, Valuation of greenhouse gas emissions: for policy appraisal and evaluation, September 2021

BEIS provides a high carbon value to represent an increased value of carbon abatements if climate conditions deteriorate in the future and more carbon reduction is required. A higher value placed on carbon abatement should signal to water companies that investment in reducing consumption and emissions is increasingly important in an adverse future climate.

Source: Frontier / Artesia analysis
Note: The headline CBA results are shown in grey, while uplifts from higher carbon values are stacked in the red and blue bars above.

Water companies also face risks from increasing population growth and higher demand for water in the future. To incorporate principles from Ofwat's high demand reference scenarios, we assume that there is additional pressure on companies to combat risks to public water-supply and impacts on the water environment[26]. AMI is expected to deliver higher incremental benefits in a high demand scenario compared to AMR, both due to the increased leakage efficiency as well as the improvement in peak demand consumption which is not expected from AMR meters. The results of the high demand scenario are presented in Figure 13 below:

FIGURE 13 ADVERSE DEMAND SCENARIO RESULTS



Source: Frontier / Artesia analysis
Note: The headline CBA results are shown in grey, while uplifts from higher carbon values are stacked in the red and blue bars above.

The key finding from the adaptive planning scenarios is that the benefits of AMI investments are resilient to high impact future scenarios. If the challenges of climate change and demand growth are more severe than expected, then the comparative net-benefit of an AMI roll-out increases further compared to AMR, given the underlying benefits in terms of data frequency and granularity which enable greater consumption and leakage benefits for AMI.

To give consideration to areas of importance for metering beyond the headline Cost-Benefit Analysis in section 3.1, this paper uses Multi-Criteria Decision Analysis (MCDA) to evaluate impacts of additional benefits. Under the MCDA assessment, AMI and AMR are scored on a 0 to 4 scale for additional benefits,

---

[26] This is modelled by increasing the high ambition consumption savings for both AMI and AMR by 1%pt. We also increase leakage efficiency savings to 20% for AMI but apply no further increase to AMR due to data frequency and granularity constraints

with 0 representing no benefits and 4 representing maximum benefits. More information on the scoring framework is available in Annex B.

MCDA ASSESSMENT SCORING[27]: ADAPTIVE PLANNING SCENARIOS

3.3 IMPACT ON PCS: AMI'S DATA CAPABILITIES ENABLE BETTER PERFORMANCE DELIVERY

Performance commitments (PCs) are the cornerstone of Ofwat's outcome regime for water companies, as they set baseline performance levels for companies and incentivise service delivery through out- and under-performance payments. They are used to measure the service that water companies deliver and drive water company performance in terms of outcomes for customers and the environment.

The use of metering technology, such as AMI and AMR, could help water companies achieve better performance individually for common (PCs) set by Ofwat. Compared to a company without AMI or AMR meters, these meters should drive consumption, leakage, environmental and engagement benefits. For the next periodic review, PR24, Ofwat is planning to set a number of performance commitments, of which the following are most relevant to smart metering.

- **C-MeX:** This is the residential customer measure of experience PC, incentivising water companies to provide an excellent customer experience for residential customers. Additional data and insights from AMI metering can help companies better engage with their customers, as insights can help target specific customer groups and needs (see section 3.4).

- **Leakage reduction:** This PC incentivises water companies to reduce water leaking from water networks, as part of progressing towards sustainable abstraction over the long term. More frequent and granular data from AMI meters allows companies to identify and respond to leakage incidents more quickly, compared to less frequent data from AMR meters.

- **Per Capita Consumption (PCC) reduction**: This PC incentivises water companies to help residential customers reduce their consumption, also as part of progressing towards sustainable abstraction over the long term. Increased insight about residential usage, by both companies and their customers, via AMI metering should help companies drive more consumption reduction and perform better on this PC.

- **Asset health and supply interruption measures:** These measures helps promote reliable water services and incentivises water companies to ensure asset health, minimise the number and duration of water supply interruptions and ensure operational resilience (specifically minimising restrictions

[27] Additional information on criteria scoring available in Annex B.

under drought conditions). Alongside other network data, metering data can help identify issues to network assets and supply interruptions and thereby reducing customer minutes lost due to interruptions.

- **Operational greenhouse gas emissions:** This is a new common PC for PR24 and will incentivise water companies to progress towards net zero emissions in their own operations. By reducing consumption, leakage and wastewater required to be treated, meters can help companies reduce energy consumption and emissions related to pumping and treatment.

The key finding from exploring impacts of meters on PCs is that metering can help companies improve performance in a number of areas, but the improvement will be dependent on the quality of data gathered by metering and actions taken by companies. AMI, due to its higher levels of data frequency and granularity, should enable companies to improve performance further than AMR – but the final level of performance improvement will depend on companies' individual levels of ambition.

MCDA ASSESSMENT SCORING[28]: IMPACT ON PCS

	AMI			AMR		
	Low	Medium	High	Low	Medium	High
Impact on PCs	1.6 / 4.0	2.8 / 4.0	4.0 / 4.0	0.8 / 4.0	1.2 / 4.0	1.6 / 4.0

Metering ambition → (AMI) Metering ambition → (AMR)

3.4 ADDITIONAL DATA BENEFITS: AMI'S DATA CAPABILITIES ENABLE ADDITIONAL BENEFITS AND OPTIONALITY

The analysis in this study captures the most material benefits and costs of AMI and AMR technologies. However, there are a number of additional benefits that could be enabled by AMI and AMR which we have not quantified in our analysis. The reasons for this are that, at this stage, there is less evidence available to quantify these impacts or that these impacts are still developing and emerging. We have nonetheless included a discussion below on key non-quantified benefits of AMI meters, in line with the Green Book guidance[29] which states that *"[where] it is not possible to monetise certain costs or benefits they should be recorded and presented as part of the appraisal. Where possible these unmonetisable values should be assessed in another way, providing an understanding of their magnitude."*

Better customer understanding and engagement

The primary purpose of any metering technology is to develop a better understanding of customer usage using consumption data. While this data is primarily used for more accurate billing and network monitoring, customer insight from meters can also be used for additional purposes. Depending on the frequency and granularity of information obtained from meters, water companies can develop a better understanding of usage patterns, impacts of weather and other aspects of customer use. Due to the higher frequency of reads enabled by AMI, companies are also better able to target BAU customer activities such as water efficiency

[28] Additional information on criteria scoring available in Annex B.

[29] HM Treasury, The Green Book: Central Government Guidance on Appraisal and Evaluation, 2020

visits and supporting vulnerable customers. Thames Water have stated that data from their smart meter network allowed them to better target their water efficiency audits[30]. Their analysis shows that visits to high consumption households lead to sustained water savings of approximately £135 annually for three years. Thames was also able to use data from their AMI meters to help support vulnerable customers, such as those with a history of payment difficulties. Visits to vulnerable customers helped hem manage their water consumption and bills more effectively, improving both customer affordability outcomes while also reducing future bad debt for the business.

CASE STUDY

Thames Water and smarter ways out of poverty

Thames Water[31] have over half a million smart meters in place, and they have harnessed the data from these to refine their approach to water efficiency - with a focus on supporting customers who find it hard to balance their budget.

Smart meter data was harnessed to identify how to maximise the effectiveness and reduction of customer bills from water efficiency visits.

The study identified how customers with affordability indicators do have opportunities to significantly reduce their water bill using water efficiency measures if they are consuming greater than 500 litres per day.

Bill reductions of between 8% and 17% were achieved. 10% of these customers gained a further benefit from a wastage fix saving a further £200 per year. Further analysis is ongoing to determine if data insights can be used to identify additional customers with affordability or safeguarding concerns to provide additional support to those customers.

Behavioural science and nudging

There are a number of other experimental benefits also enabled by the more frequent data provided by AMI meters, such as behavioural nudges linked to customer insight. For example, these could be in the form of "nudge letters" which inform households of greater than average water consumption, as compared to their peers or neighbours. Similar approaches have been used for behaviour change in other sectors, such as the HMRC's use of nudge letters to improve tax compliance and filing times[32]. Future advancements in other emerging technologies, such as internet-enabled appliances and household automation may also enable communication between AMI meters and other technologies to foster increased automation and optimise water usage.

---

[30] Thames Water, Smarter ways out of water poverty, December 2021

[31] Ibid.

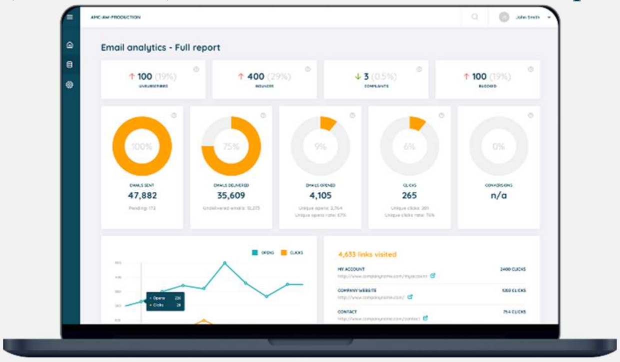
[32] Tax Adviser Magazine, Nudging taxpayer behaviour, April 2018

CASE STUDY

Anglian Water and putting behavioural science to the test

In 2017, Anglian Water and Advizzo[33] teamed up to deploy a data and behavioural science customer engagement strategy to help customers reduce water consumption.

The project focussed on 4,500 households in Newmarket, Colchester, and Essex. Customers were split into groups which consisted of different intervention treatments.



A bespoke water usage portal was developed specifically for this project and was coupled with smart meter deployment for participating customers. The portal provided customers with access and insight into their water consumption, including comparisons to other households in the area. The project team observed the following key findings:

- 15% of customers signed up to access the portal.
- 12,500 litres per day saved in Newmarket area.

8% water consumption reduction was achieved in Newmarket's measured customers over a 12-month period.

Wider network options and spill-overs

As described in section 2 above, AMR meters generally rely on reads from drive-bys by meter readers within companies or third party agents, such as a waste company using their refuse truck routes. In contrast, the AMI approach relies on a communication network, such as Arqiva's fixed communication network. The use of a network allows for scale beyond just household meters, enabling potential spill-over benefits from available network capacity to capture and relay data from non-household and wastewater network meters. Optionality around future network data integration is high, as the marginal cost of connecting other meters to the fixed network is lower than alternative options. For example, non-household smart meters could be installed and benefits could be derived from identifying wasted consumption, leaking supply pipes and wider insight on data across the water network.

An investment in a fixed network AMI approach can therefore have key benefits in terms of future options created, such as the option to extend metering to non-household (NHH) customers and to use the network to monitor other aspects of service such as wastewater networks. A key aspect of the PR24 adaptive planning guidance is the focus on adaptive pathways and optionality created by partial or complete investments[34]. An

[33] Advizzo, Anglian Water and Advizzo reduce water consumption in the East of England through behavioural and data science, webpage

[34] Ofwat, PR24 and beyond: Final guidance on long-term delivery strategies, April 2022

AMI metering investment could create optionality for monitoring NHH customers and other parts of water companies' networks, as the fixed network has enough capacity to capture and relay data from non-household and distribution network meters.

Innovative tariffs and customer insight

Greater and more timely information on water usage could also enable innovation in charging and tariffs. Currently, Ofwat's guidance to metered customers is that *"If you have a water meter, it should be read at least once a year, and read by your water company at least once every two years"*[35]. This is due to the inherent difficulty and infrequency in reading dumb and AMR meters, stemming from the marginal costs of reading meters and missed reads. More frequent data via AMI meters could permit a much wider and flexible range of tariff options to be introduced in the future, such as time-of-use tariffs, peak demand tariffs and drought resilience tariffs. The optionality to create innovative tariffs is likely to have a positive value, as such tariffs will likely to deliver greater consumption reductions and protect the resilience of water supplies.

CASE STUDY

IWA and profiling customers through digital technology

In 2018 the IWA published some research[36] showing how it was possible to profile customers into clusters using hourly consumption data from smart meters. The work was part of a larger study for UKWIR[37] into the integration of behaviour change into water efficiency practices. The approach had been used previously in the energy sector to profile electricity customers based on their sub-daily demand, but this was the first time it was applied to water consumption. The approach was further developed by an UKWIR[38] project in 2021 looking at how to improve the understanding of household consumption.

The approach illustrates the power of using sub-daily consumption data to better understand how people use water, looking for common and different patterns of water use. As smart metering becomes more widespread, these techniques have the potential to help drive behaviour change and help people use water more efficiently.

[35] Ofwat, Metered customers and applying for metered charges, webpage

[36] IWA, Profiling customers through digital technology, November 2018

[37] UKWIR, Integration of behavioural change into demand forecasting and water efficiency practices, 2016

[38] UKWIR. Improved understanding of current and future household consumption, 2021

Other miscellaneous benefits

AMI may also enable benefits around 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 on roads and bending frequently to read below-ground meters. AMR meters will also allow identification of backflow from a property into a main, reducing the potential risk of contamination of drinking water supply. The value of these potential benefits has not been quantified in the CBA analysis due to a lack of robust information available on them.

The key finding on additional benefits is that AMI technology can enable a wider range of benefits and optionality for companies than AMR approaches. Additional data and insight derived from AMI can help companies better target and engage with customers, drive behavioural change and innovate their approaches to charging. The fixed networks and back office processes used for AMI can also enable wider network spill-over benefits in the future, while AMI can also help companies improve in areas such as employee health & safety as well as backflow management.

MCDA ASSESSMENT SCORING[39]: ADDITIONAL BENEFITS

	AMI			AMR		
	Low	Medium	High	Low	Medium	High
Additional benefits	2.0 / 4.0	3.2 / 4.0	3.7 / 4.0	0.8 / 4.0	1.3 / 4.0	1.5 / 4.0

Metering ambition → (AMI) | Metering ambition → (AMR)

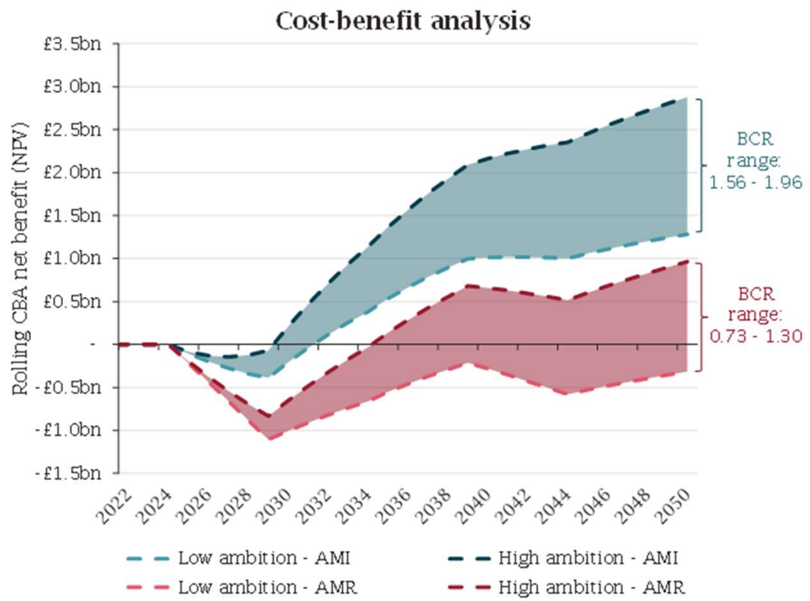
[39] Additional information on criteria scoring available in Annex B.

4 CONCLUSIONS

4.1 SUMMARY OF RESULTS

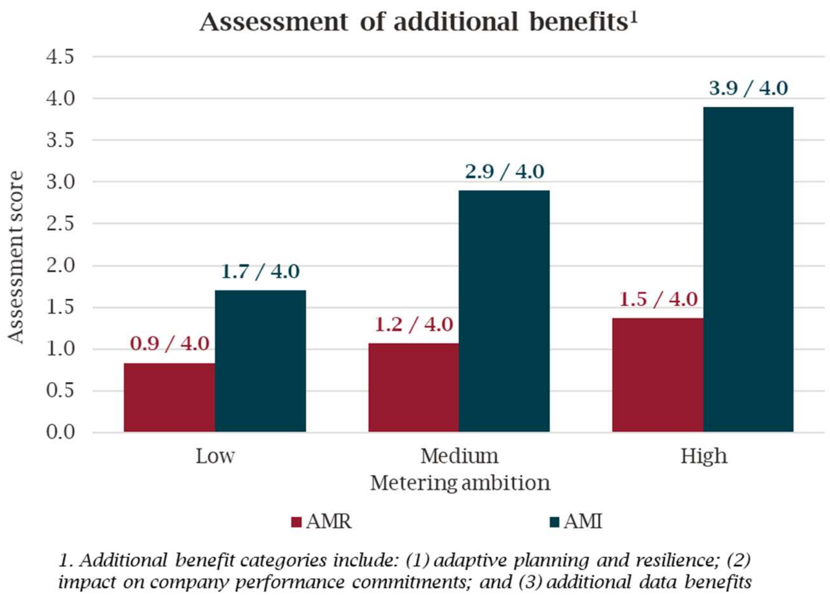
Our findings in this report are based on the expected costs and benefits of AMI and AMR metering roll-outs across England and Wales, alongside a qualitative assessment of other key benefits assessed from the perspective of both water companies and their customers. For the qualitative assessment of additional benefits, we focus on adaptive planning and resilience; impact on company performance commitments; and additional data benefits for customers. AMI and AMR are then scored on a 0 to 4 scale for additional benefits, with 0 representing no benefits and 4 representing maximum benefits[40].

FIGURE 14 AMI OUTPERFORMS AMR IN THE COST-BENEFIT ANALYSIS OVER TIME...



Source: Frontier / Artesia analysis

FIGURE 15 ... WHILE ALSO SCORING HIGHER THAN AMR FOR ADDITIONAL BENEFITS



Source: Frontier / Artesia assessment of additional benefits

40 Additional information on criteria scoring available in Annex B.

4.2 IMPLICATIONS FOR WATER COMPANIES AT PR24

Water companies face a large number of challenges over the coming 25 years, with Water UK's 2050 Vision stressing risks from the climate emergency, increasing population size, ageing assets, rising environmental standards and increased customer, community and societal demands[41]. Water companies will have to square these challenges with stretching commitments and targets set for the future, as well as ensuring value-for-money. Defra's Strategic Policy Statement for Ofwat states that water companies should *"plan, invest in, and operate its water and wastewater services to secure the needs of current and future customers, in a way which delivers value to customers, the environment and wider society over the long-term"[42].*

Metering represents one of the few multi-benefit solutions available to companies. Metering water usage can help companies respond to these challenges and commitments, by encouraging consumption reduction, improving the accuracy and fairness of bills, helping manage the water network and enabling wider societal benefits.

However, the decision around metering is not solely about the type of water meters companies want to install at customers' premises. The choice is about how ambitious a company wants to be to deliver outcomes required by society in the face of large external challenges. In particular, companies' ambition and choices for metering will determine whether the company is willing and able to unlock the potential of data to transform the way it provides services to customers and the environment, or whether it is content to take a more incremental approach. While companies can evolve their ambition over time, the choice around metering technology will help determine how far their ambition takes them – and the decision around technology, once made, will be both costly and difficult to change.

Our analysis in this paper considers both quantitative costs and benefits of AMI and AMR metering, alongside a qualitative assessment of other key impacts assessed from the perspective of both water companies and their customers. Our main finding for water companies is that **AMI can enable much more ambitious outcomes for customers and society than AMR:**

- Our cost-benefit analysis highlights the higher data benefits achievable from AMI compared to AMR, with AMI expected to deliver £1.3bn to £2.2bn in net benefits across England and Wales compared to £30m to £0.4bn achievable through AMR. These benefits stem largely from enabling reduced water consumption, lower carbon emissions, increased leakage cost efficiency and avoided data and meter costs.

- We have also explored additional benefits achievable through metering, such as improved customer engagement and experience, additional customer insight and potential future solutions such as innovative tariffs. AMI outperforms AMR across these additional benefits as well, due to its ability to gather much more complete and actionable data.

- We also considered the impact of AMI and AMR on individual companies' performance. Focusing on company performance commitments, AMI is more likely to improve company performance in a number of areas, relative to other companies which do not use smart metering. An AMI approach to metering therefore is more likely to allow companies to be rewarded rather than penalised by their

[41] Water UK, Developing a 2050 Vision for the Water Sector: A Discussion Paper, March 2021

regulators who will continue to set financial and reputational incentives by reference to the best-performing companies in these areas.

As seen from these findings, the use of data that AMI enables can impact the way services are provided across the value chain and have the potential to transform how water companies provide their services. We also find that the additional benefits of AMI identified in this report extend well beyond those related to future water resource management. Our first key recommendation directed at water companies is therefore:

Recommendation 1

Water companies	**In the coming investment planning round companies should analyse their metering investment choices in a strategic and holistic way. These choices should align with a wider long-term strategy for engagement of all customers, integrating data from smart networks, and for unlocking the power of data across the business.**

Due to the unprecedented external challenges companies face at PR24, Ofwat has asked companies to show that they are optimising the profile of their key interventions across time, ensuring that decisions are not avoided when they are needed – for example, to ensure resilience against high-impact scenarios – while minimising the risk of stranded assets should low impact scenarios come to pass. Our analysis shows that benefits of **AMI investments are resilient to high impact future scenarios and points to AMI being a "low-regret" investment for companies to undertake:**

- If the challenges of climate change and demand growth are more severe than expected, then the comparative net-benefit of an AMI roll-out increases further compared to AMR, given the underlying benefits in terms of data frequency and granularity which enable greater consumption and leakage benefits for AMI.

- AMI enables more optionality than AMR. The options to utilise the data and insights that AMI can provide are much harder or not possible to replicate under AMR.

At the same time **any potential benefits from delaying investment on AMI appear to be small**:

- First, the relatively short asset lives of metering infrastructure (for example, compared to the asset lives of other water projects such as reservoirs or pipelines) means delaying the investment in expectation of falling costs is a minor consideration.

- Second, companies may have a reason to delay investment if there were plausible future scenarios where the wider company strategy does not depend on the adoption of smart data technologies, particularly given the organisational time and effort required around staff, processes, systems and culture. However, in our view, these scenarios are very unlikely as data becomes an increasingly integral part of water company processes.

- On the other hand, the opportunity costs to delaying a decision to invest in AMI could be material. Our cost-benefit analysis shows that AMI delivers substantial positive net-benefits and more quickly than AMR.

- In addition, there is a growing body of experience of AMI and smart water data in England (across water companies and the supply chain) that other water companies can learn and benefit from. It is likely that best practice performance will be increasingly set by companies that have invested in smart technologies.

- Finally, the five-year planning cycle means that a delay at this stage could push the rollout of AMI for some companies into the mid-2030s, increasing pressure to deliver leakage or consumption reduction targets across different scenarios.

Therefore, our analysis indicates that there is no case to delay investment in AMI. Our second and third key recommendations for water companies are therefore:

Recommendation 2

Water companies	**In applying the Adaptive Planning Framework to metering investment companies should account for the greater optionality that AMI provides relative to AMR. Companies should also recognise that the internal investment and reorganisation needed to achieve the benefits of AMI is likely to be part of a wider data strategy and therefore very unlikely to be a stranded cost.**

Recommendation 3

Water companies	**Companies should also consider the risks of delaying a decision to invest in AMI and how this would affect their ability to deliver leakage and consumption reduction during the 2030s. Companies should consider that the use of the technology is becoming increasingly mature and is likely to define best practice performance in the sector.**

4.3 IMPLICATIONS FOR OFWAT AT PR24

Future challenges facing the water sector are unprecedented and uncertain, so Ofwat has asked companies to ensure their long-term plans are resilient and adaptable[43]. Companies need to show how they are optimising the profile of their key interventions across time, ensuring that decisions are not avoided when they are needed – for example, to ensure resilience against high-impact scenarios. The downside risk from companies not undertaking appropriate investment is high, the Environment Agency has identified the need to improve the balance between water supply and demand by approximately 3,300 million litres per day[44] in order to address future resource challenges in a drier climate.

But there remains a risk that companies will make more incremental changes rather than displaying ambition, as the exact impacts of external challenges remain uncertain. Embracing data and smart metering will require more radical change across company organisations in terms of its people and culture, processes and systems. Compared to traditional metering approaches, such as dumb metering and AMR, the AMI approach necessarily requires more ambition from companies. But, as explained above, our analysis shows that the **benefits from AMI are resilient to high impact future scenarios and that AMI has many of the attributes of a "low regret" investment.**

Ofwat will need to ensure that companies make purposeful efforts to tackle future challenges, as Defra expects Ofwat to *"Hold companies to account for their contribution towards reducing personal water*

---

[43] Ofwat, PR24 and beyond: Final guidance on long-term delivery strategies, April 2022

[44] Environment Agency, Meeting our Future Water Needs: a National Framework for Water Resources, 2020

consumption to 110 litres of water per head per day (l/h/d) by 2050"[45]. Our recommendation for Ofwat is therefore to ensure that companies' plans consider benefits from metering holistically and meaningfully:

Recommendation 4

Ofwat	**When assessing investment strategies for metering Ofwat should challenge companies on whether they have considered the full range of benefits metering options may enable.** **Ofwat should recognise that the full benefits of AMI involves wider investment and reorganisation in company processes.** **Ofwat should recognise that the benefits develop over time and ensure that the assessment of business plans does not favour short-term options.** **If a case is made to delay investment in AMI Ofwat should challenge companies that they have considered the additional optionality of AMI and the 'low regret' nature of the investment.**

[45] Defra, The government's strategic priorities for Ofwat, February 2022

ANNEX A - APPROACH TO EVALUATION OF METER OPTIONS

A.1 - SUMMARY OF NOVEMBER 2021 ANALYSIS

This report builds on the analysis undertaken in our November 2021 cost-benefit analysis of AMI metering for Arqiva[46]. The modelling approach is based on a methodology report published by UKWIR in 2012[47], which identified a range of costs and benefits associated with smart meters and the methodology by which to convert these into values per household.

The November 2021 analysis focussed on two AMI scenarios, which differed in their treatment of previously unmetered households and their transitions to measured tariffs. The counterfactual to the AMI roll-outs was the existing costs and benefits under a business-as-usual approach to metering by each water company. The analysis was undertaken at the individual company level across the 18 water companies in England and Wales. The analysis also reflected best practice in cost-benefit analysis and was consistent with HM Treasury Green Book methods for evaluation.

FIGURE 16 SUMMARY OF NOVEMBER 2021 ANALYSIS

Source: Frontier / Artesia analysis

The previous analysis highlighted a strong positive case for AMI, with almost £4.4 billion in expected benefits compared to costs of £2.5 billion resulting in net benefits of £1.9 billion. The positive case for AMI was present for each company and region in England and Wales and corresponded to a weighted average 1.73 benefit-to-cost ratio across the sample.

A.2 - COST-BENEFIT ANALYSIS OF AMI AND AMR

[46] Frontier Economics and Artesia, Report: Cost benefit analysis of water smart metering, November 2021

[47] UKWIR, Smart Metering in the water sector phase 3: Making the case, November 2012

Building on the previous November 2021 study, the analysis in this paper now focusses on evaluating AMI and AMR metering roll-outs in relation to each other. For both metering technologies, we focus on the aggregate CBA results for England and Wales[48] with an equivalent roll-out of at least 80% metering penetration by the end of AMP8, or higher if BAU plans exceed 80% penetration. We create three scenarios for each metering technology according to the benefits achievable under three levels of metering ambition, as described in Figure 17 below. These scenarios reflect different of levels of ambition water companies exhibit in driving data benefits from their metering programmes.

FIGURE 17 AMBITION SCENARIOS USED IN THE CBA MODELLING

	Low ambition – Focus on cost efficiency	Medium ambition – Focus on demand and leakage	High ambition – Maximising data and outcomes
AMR	Modelled benefits include: ▪ Lower meter reading costs vs dumb meters ▪ Some data benefits – related to avoided costs of PCC and NU monitors	Low ambition benefits, plus: ▪ Incremental consumption reduction vs Dumb meters due to more accurate billing (but lower benefit than AMI) ▪ Low efficiency gains related to leakage costs, relative to AMI	Medium ambition benefits, plus: ▪ Increased leakage efficiency and consumption gains, but lower than medium AMI due to data granularity and frequency constraints ▪ Unmodelled: Customer insight, more complex tariffs
AMI	Modelled benefits include: ▪ Basic consumption benefits (including capacity and carbon) ▪ Basic leakage benefits ▪ Fully avoided meter reading costs ▪ Fully avoided costs of PCC and NU monitors	Low ambition benefits, plus: ▪ Improved consumption benefits (including capacity and carbon) ▪ Improved leakage cost efficiency ▪ Full infrastructure management benefits	Medium ambition benefits, plus: ▪ Additional consumption benefits from innovative tariffs and behaviour change ▪ Unmodelled: Customer insight, Behavioural interventions, AI, spill-over benefits to NHHs and wastewater

Source: Frontier/Artesia

As discussed in section 2.5, companies can focus on different aspects of data and benefits based on their level of ambition. However, technology choice is an important determinant of the level of data and benefits actually achievable by a company. Therefore, even for the same level of ambition, AMI is modelled to achieve higher levels of benefits due to its advantages in data frequency and granularity, as discussed in section 2.4. More detailed information on the approach to modelling ambition and input assumptions is available in Annex B.

As in the initial November 2021 analysis, the modelling of costs and benefits of metering is conducted over a 30-year horizon, starting in 2021/22 and running until 2050/51. The results are presented at the societal level, based on the costs and benefits faced by both private water companies as well as wider society. The analysis also reflects best practice in cost-benefit analysis and is consistent with HM Treasury Green Book methods for evaluation, including discounting benefits and costs according to the Green Book social discount rate to estimate the net present value (NPV) of results.

The cost-benefit modelling in this paper uses the same model engine as the previous November 2021 study, which is based on company-level inputs from public sources, including Ofwat submissions such as WRMI tables and water company WRMP tables. For both AMI and AMR roll-outs, it is assumed that the underlying

[48] The underlying modelling is performed using data from individual water companies, as per the initial November 2021 study. We exclude Anglian and Thames' data as both companies have already rolled out AMI meters as part of their BAU plans. Including them in the sample would reduce the intuitiveness of results, as the CBA analysis is based on a comparison of an AMI or AMR roll-out to the BAU counterfactual for each company which in the cases of Anglian and Thames is already AMI-based.

companies will be able to reach 80% metering penetration or higher[49] by the end of 2030. Cost-benefit results are derived against a counterfactual based on companies' respective BAU metering plans. Information for costs are based on industry research and are grouped in four main categories: meter device costs; meter installation costs; meter read and communications costs; and back office and programme costs.

As per the November 2021 study, there are also seven high-level categories of benefits. 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.

The key advancement of the CBA approach in this paper is the use of three ambition scenarios for AMI and AMR technology each, as described in section 2.5. The scenarios reflect both the level of benefits achievable through the characteristics inherent to the two metering technologies, as described in section 3, and water companies' priorities for metering. Figure 18 below presents the main cost and benefit assumptions used in the modelling. As seen in the benefits assumptions, the three ambition scenarios chiefly drive variation in the leakage efficiency and consumption reduction benefits, and to a lower extent in the infrastructure management benefits. The differences between the AMI and AMR scenarios are primarily based on the higher levels of data frequency and granularity achievable through AMI metering, which lends itself to enabling more ambition in outcomes that companies can achieve through metering.

FIGURE 18 KEY MODEL ASSUMPTIONS FOR COSTS AND BENEFITS

	Parameter	Description	AMR	AMI
Costs	**Meter device cost**	▪ Industry standard values for AMR ▪ Smart meter costs are part of Arqiva contract	£40 / meter	£4.2 / meter / year
Costs	**Meter installation cost**	▪ Based on Green Economic Recovery final determination	£65 for "easy" installation and £275 for "difficult" installation with boundary box	
Costs	**Meter read / communications costs**	▪ Industry standard values for AMR ▪ Smart meter costs are part of Arqiva contract	£2.1 / meter / year	£4.1 / meter / year
Costs	**Back office and programme costs**	▪ Fixed and variable costs per company, adjusted for smaller companies ▪ Fixed cost is amortised over useful life of meters (15 years for all meter types)	▪ Variable: £2.1 / meter / year ▪ Fixed: £9.1m	▪ Variable: £2.3 / meter / year ▪ Fixed: £14.0m
Benefits	**More efficient leakage delivery**	▪ Leakage management cost efficiency, relative to BAU leakage costs	▪ Low: No benefit ▪ Medium: 5% ▪ High: 7.5%	▪ Low: 7.5% ▪ Medium: 15% ▪ High: 15%
Benefits	**Consumption savings – consumption costs**	▪ Lower demand results in lower volumes of water into supply and sewage, based on marginal cost of water ▪ Savings presented relative to no meter	▪ Low: 10% ▪ Medium: 11% ▪ High: 12%	▪ Low: 15% ▪ Medium: 16% ▪ High: 17%
Benefits	**Consumption savings – avoided capacity costs**	▪ WRMP19 final plan investments used to determine avoided costs of investment	Based on company-level capacity costs derived from WRMPs multiplied by cons. saving above	
Benefits	**Consumption savings – Lower carbon emissions**	▪ Reduced emissions from customer's heating of water and company energy consumption	Based on Low Carbon Values from BEIS multiplied by cons. saving above	
Benefits	**Reduced meter reading costs**	▪ Reduced or avoided meter read costs	Some meter read costs avoided – £2.4 / meter per year	All meter read costs avoided – £4.5 / meter per year
Benefits	**Improved infrastructure management**	▪ Benefits of better data for better targeting of mains replacement	No benefit	▪ Low: No benefit ▪ Medium & High: £0.8 / meter (avoided cost)
Benefits	**Improved forecasting data**	▪ Avoided costs of running PCC and night use monitors	£0.25 / meter (avoided cost)	£0.50 / meter (avoided cost)

[49] This will be determined by the higher value of either: (A) companies' BAU metering penetration plans, or (B) the 80% metering target.

Source: Frontier/Artesia, based on information from industry research

A.3 - MULTI-CRITERIA DECISION ANALYSIS USED TO ANALYSE ADDITIONAL BENEFITS

To give consideration to a number of additional areas which are impacted by metering, this paper uses Multi-Criteria Decision Analysis (MCDA). MCDA looks at findings from different techniques and criteria, and applies weights to these results to enable a holistic evaluation of different options. MCDA is a decision-making technique which is used in government appraisals, with Government guidance stating that MCDA can help "deal with the difficulties that human decision-makers have been shown to have in handling large amounts of complex information in a consistent way"[50].

In addition to the headline CBA results our paper, the MCDA focuses on the three other areas of:

- Adaptive planning scenario analysis
- Impact on company performance commitments (PCs)
- Additional data benefits

For simplicity, all criteria are given equal weighting. AMI and AMR are then scored on a 0 to 4 scale for all criteria, with 0 representing no benefits and 4 representing maximum benefits. The scoring framework for each criteria is explained in Annex B. Metering ambition, as discussed in section 2.5, is also applied as an overlay to the MCDA criteria to illustrate the interaction between metering technology choices and the priorities of water companies from their metering programmes.

A.4 - APPLYING PRINCIPLES OF OFWAT'S ADAPTIVE PLANNING GUIDANCE

Our approach also considers Ofwat's guidance on long-term investment planning for PR24[51]. Ofwat's guidance emphasises the need for water companies to plan for long-term challenges, such as climate change, population growth and increasing consumer expectations. Companies are asked to focus on ensuring long-term resilience and developing long-term delivery strategies that go beyond normal 5-year planning cycles. To help companies develop these long-term plans, Ofwat has described a number of future reference scenarios to help plan for uncertain outcomes in the areas of climate change, technology, demand and environmental ambition. These scenarios can help companies take into account plausible future challenges over the horizon to 2050, but Ofwat has also stated that these scenarios *"are not intended to be exhaustive or comprehensive, but represent approximations of how certain factors may develop".*

In its guidance for long-term and adaptive planning at PR24, Ofwat has described a number of future reference scenarios to help plan for uncertain outcomes in the areas of climate change, technology, demand and abstraction. As these reference scenarios are aimed primarily at water companies and their planning processes, we have used principles from the PR24 reference scenarios for climate change and demand to create two adverse future scenarios for the CBA analysis. The PR24 technology reference scenario is less relevant to this study, as it assumes a smart meter roll-out which is already modelled in our analysis. The abstraction scenarios focus on the Environment Agency's approaches to environmental protection and abstraction, which are not related to benefits from the metering options analysed in this study.

---

[50] Department for Communities and Local Government, Multi-criteria analysis: a manual, 2009

[51] Ofwat, PR24 and beyond: Final guidance on long-term delivery strategies, April 2022

Ofwat has also asked companies to use adaptive planning techniques to ensure that companies' plans are flexible enough to adapt to changes in future circumstances. This involves companies considering the timing of future investment decisions, to ensure that investments are resilient to future uncertainties while also minimising the risk of stranded assets (i.e. major investments that turn out to not be required or fully utilised). Companies should also plan for investment decisions to be made at the right time, rather than delayed or avoided simply due to uncertainties around future circumstances.

The value of long-term and adaptive planning is evident in the context of major projects with long development timeframes and asset lives (e.g. reservoirs and desalination plants). However, Ofwat's guidance also highlights that a long-term and adaptive approach to planning is applicable to a wider range of investments, including investments such as AMI and AMR which can help create *"behaviour change, for example to reduce water use"*. This paper's cost-benefit analysis reflects these long-term planning principles, by considering how reference scenarios could interact with the drivers of AMI and AMR benefits and analysing the investment decision between a AMI or AMR approach.

ANNEX B - MULTI-CRITERIA DECISION ANALYSIS

As discussed in Annex A.3, we use multi-criteria decision analysis (MCDA) to evaluate additional benefits of AMI and AMR metering beyond the headline Cost-Benefit Analysis. These additional areas include: (1) adaptive planning scenario analysis; (2) impact on company performance commitments (PCs); and (3) additional data benefits. This annex details the scoring frameworks by which we arrive at the MCDA evaluation results, as well as the MCDA scoring results for AMI and AMR across the three additional evaluation areas.

B.1 - MCDA SCORING FRAMEWORKS

For the first area of adaptive planning scenario analysis, we explored three different criteria around the ability of data to adapt to future challenges in adverse scenarios. The impacts of AMI and AMR metering data were evaluated using judgement and results of the scenario CBA across a spectrum of lower and upper bound scores of 0 and 4, based on the ability of metering data to influence change in the adverse scenarios.

FIGURE 19 MCDA SCORING FRAMEWORK FOR ADAPTIVE PLANNING SCENARIO ANALYSIS

Adaptive planning scenario analysis	Description of result	Lower and upper bound scores
Criteria 1: Can metering data be used to adapt to future challenges of increased needs for demand reduction?	No, the metering data does not allow further demand reductions	0
	Yes, data is near real-time	4
Criteria 2: Can metering data be used to adapt to future challenges of increased climate impacts?	No, scaling up of data granularity does not allow adaptation to climate impacts	0
	Yes, scaling up of data granularity does allow significant adaptation to CC	4

Criteria 3: Can metering data be used to take account of short term needs, e.g. in reducing demand in a drought?	No, the metering data does not allow further demand reductions	0
	Yes, data is near real-time	4

Source: Frontier / Artesia analysis

For the second area of impact on company performance commitments, we explored five different criteria which looked at the use of metering data to improve PC outcomes for companies. The impacts of AMI and AMR metering data were evaluated using judgement across three bounds for assessment scores, based on the ability of metering data to impact PC outcomes for companies.

FIGURE 20 MCDA SCORING FRAMEWORK FOR IMPACT ON COMPANY PERFORMANCE COMMITMENTS

Impact on performance commitments	Description of result	Scores
Criteria 1: Can metering data be used to reduce risk of exceeding leakage targets?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 2: Can metering data be used to reduce risk of exceeding PCC targets?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 3: Can metering data be used to score highly in customer measures excellent service (C-MeX)?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 4: Can metering data be used to reduce the risk of exceeding supply interruption targets?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 5: Can metering data be used to improve asset health (e.g. by improving the targeting of asset health improvements)	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4

Source: Frontier / Artesia analysis

For the final MCDA area of additional data benefits, we explored six different criteria which looked at the use of metering data to enable additional benefits for companies and customers. The impacts of AMI and AMR metering data were evaluated using judgement across three bounds for assessment scores, based on the ability of metering data to build options for additional benefits.

FIGURE 21 MCDA SCORING FRAMEWORK FOR ADDITIONAL DATA BENEFITS

Additional data benefits	Description of result	Scores

Criteria 1: Can metering data be used to help segment customers with respect to water use and water needs?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 2: Can metering data be used to help deliver added value services to customers?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 3: Does the metering data help with climate change mitigation?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 4: Does the metering data help improve workforce H&S?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 5: Does the metering data help bad debt management?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4
Criteria 6: Does the metering data improve with backflow detection?	No	0
	Yes, to some extent	1-3
	Yes, data is near real-time and granular to a sub-daily level	4

Source: Frontier / Artesia analysis

B.2 - MCDA SCORING RESULTS

FIGURE 22 MCDA EVALUATIONS SCORES MATRIX

Area	AMI			AMR		
	Low maturity	Medium maturity	High maturity	Low maturity	Medium maturity	High maturity
Adaptive planning scenario analysis						
Can metering data be used to adapt to future challenges of increased needs for demand reduction?	2.0	3.0	4.0	1.0	1.0	2.0
Can metering data be used to adapt to future challenges of increased climate impacts?	1.0	2.0	4.0	1.0	1.0	1.0
Can metering data be used to take account of short term needs, e.g. in reducing demand in a drought?	1.0	2.0	4.0	1.0	1.0	1.0
Average score	**1.3**	**2.3**	**4.0**	**1.0**	**1.0**	**1.3**
Impact on performance commitments						
Can metering data be used to reduce risk of exceeding leakage targets?	2.0	3.0	4.0	1.0	2.0	2.0
Can metering data be used to reduce risk of exceeding PCC targets?	2.0	3.0	4.0	1.0	2.0	2.0
Can metering data be used to score highly in customer measures excellent service (C-MeX)?	2.0	3.0	4.0	1.0	1.0	2.0
Can metering data be used to reduce the risk of exceeding supply interruption targets?	2.0	3.0	4.0	1.0	1.0	1.0
Can metering data be used to improve asset health (e.g.by improving the targeting of asset health improvements?)	0.0	2.0	4.0	0.0	0.0	1.0
Average score	**1.6**	**2.8**	**4.0**	**0.8**	**1.2**	**1.6**
Additional data benefits						
Can metering data be used to help segment customers with respect to water use and water needs?	2.0	4.0	4.0	1.0	2.0	2.0
Can metering data be used to help deliver added value services to customers?	2.0	3.0	4.0	1.0	1.0	1.0
Does the metering data help with climate change mitigation?	3.0	4.0	4.0	1.0	2.0	2.0
Does the metering data help improve workforce H&S?	2.0	3.0	4.0	1.0	2.0	2.0
Does the metering data help bad debt management?	0.0	1.0	2.0	1.0	1.0	2.0
Does the metering data improve with backflow detection?	3.0	4.0	4.0	0.0	0.0	0.0
Average score	**2.0**	**3.2**	**3.7**	**0.8**	**1.3**	**1.5**
Overall MCDA evaluation score	**1.7**	**2.9**	**3.9**	**0.9**	**1.2**	**1.5**

Source: Frontier / Artesia analysis