Attachment #2

Tauranga City Council
AMR Pilot Project
Report

April 2009

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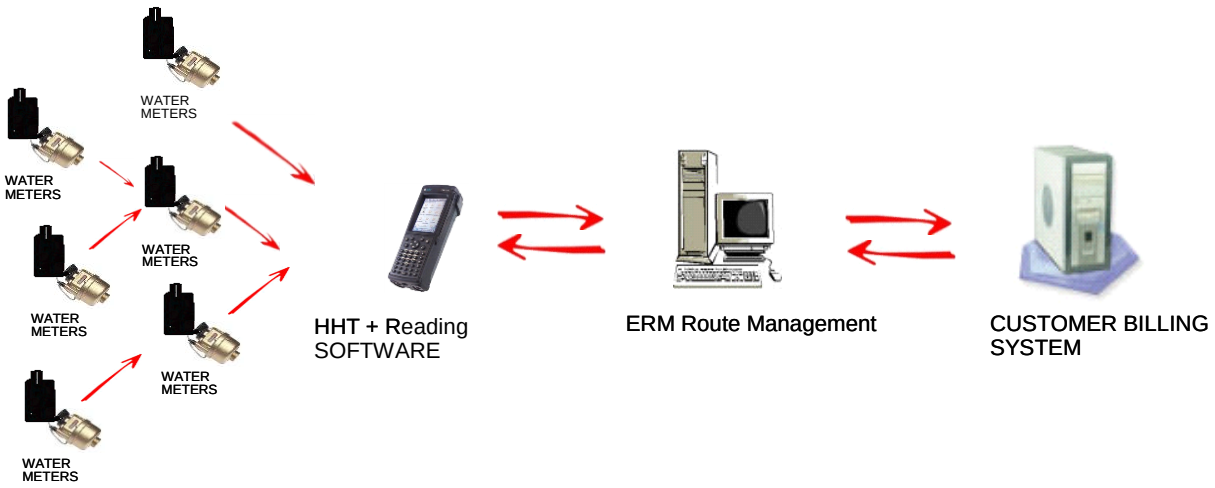
Terminology and Acronyms

AMR	Automatic Meter Reading
AMI	Automatic Metering Infrastructure (also referred to as Fixed Network)
Architecture	System layout and configuration
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Service
H&S	Health and Safety
HHT	Hand Held Terminal
RF	Radio Frequency
TCC	Tauranga City Council

1 Executive Summary

Universal metering was adopted and implemented by Tauranga City Council (TCC) in 2002 for reasons of equitable billing (for water consumed) as well as improved Water Demand



Management (WDM). Approximately 46,000 domestic meters have been installed to date and the quarterly meter readings are used for various purposes such as billing customers for consumption, consumption analysis, water balancing and demand management initiatives. These meters are of the MSM variety and installed in manifolds (including isolating valve and dual check valves) in below ground meter boxes.

In order to address various challenges which face TCC, such as the need to delay the implementation of the Waiari water supply scheme, TCC has developed a WDM protocol which considers various initiatives to manage demand and extend the life of existing water infrastructure assets. WDM relies on (amongst other things), reliable water consumption data for water balancing and this in turn relies on the accuracy and frequency of water meter readings. Research has shown that these requirements can be more efficiently and effectively achieved by implementing automatic meter reading (AMR) also referred to as *Smart Metering*. TCC is therefore investigating AMR technology with the following objectives in mind:

- Improving meter reading efficiency and accuracy and hence improving water balancing and enabling prioritised reduction of non-revenue water (commercial losses and leakage)
- Provide more frequent information for consumption analysis and stepped/seasonal water tariff if this is further considered as a WDM tool
- Identify leakage more efficiently and, together with the WaterLine education program, communicate on-site leakage and consumption profiles more regularly and effectively to customers
- Identify backflow incidents and act appropriately to minimise health and safety risks.

AMR technology, in a nutshell comprises the ability to read meters remotely using radio frequency (RF) technology, illustrated as follows:

Key infrastructure that needs to be added to the meter fleet include ***transponders*** which register pulses generated by the water meter, ***hand-held terminals (HHT)*** which are used by meter readers to communicate with transponders (walk-by or drive-by), software which communicates the information to Origen for billing purposes and for reporting purposes e.g. leaks, backflows, anomalies.

The alternative to AMR is Automatic Meter Infrastructure (AMI) which is gaining international popularity. AMI includes the communication of information from transponders in the field using a combination of RF and GSM technology to the billing and management systems. This precludes the need for meter readers and allows near-real time consumption, leakage and backflow monitoring which further improves WDM efficiency and information communicated to the customers.

A pilot study was conducted during the course of the past 6 months with three AMR vendors and comprised the installation of 228 AMR units in various locations such as gated communities and the Mount CBD. The objectives of the pilot were to assess the functionality of available technology, the compatibility of vendor solutions towards an integrated TCC solution, the software and back-office/ admin implications for TCC and to develop a business case which would explore the economic benefits of AMR implementation in the longer term.

Vendor performance was rated in a scoring process that considered technical attributes and functionality of AMR infrastructure as well as implementation and support performance. This encouraged healthy competition and a useful platform for evaluation. TCC staff undertook various independent field surveys to verify findings. Whilst this highlighted more anomalies, it also proved that very efficient read rates as well as drive-by reads can be achieved in certain circumstances.

The AMR pilot project has been beneficial in gaining a good understanding of the technology as well as challenges and options that perhaps weren't as obvious at the outset. Whilst it has clearly demonstrated the required objectives, meter reading efficiency was found to vary substantially, partially due to the fact that TCC meters are buried and often in poor locations but also as a result of certain vendors not having optimised read route configurations.

The cost of implementation of AMR for the entire meter fleet is substantial (in the order of $5m) and a business case is being developed which will appraise the long term costs and benefits of AMR implementation for Council. More work is required in this regard to quantify and/or apportion financial benefits associated with, for example, deferment of operational and capital expenditure for the proposed Waiari water supply scheme, reduced administrative fee and improved customer information/service resulting from AMR implementation.

In order to explore the drivers and gains achieved by other AMR users, various international water service providers have been approached to share experiences. Whilst their drivers generally revolve around improved meter reading accuracy and efficiency, backflow and leakage detection, peripheral benefits which were reported included improved customer services, facilitation of stepped and seasonal tariff structuring and community (e.g. gated community) driven initiatives relating meter reading access and privacy.

Whilst the pilot project has clearly demonstrated the functionality of AMR technology it has also highlighted a need for further investigations to optimise the application of the technology

in Tauranga and to substantiate certain benefits. As a way forward therefore, a phased approach is recommended that includes:

- Implement AMR as a *business as usual* improvement at sites where the technology has already been beneficially applied in TCC including large consumer sites, difficult to access locations and deep bulk meter chambers (H&S reasons)
- Approach vendors to extend and "operationalise" the pilot project to address the above issues in an operational environment and negotiate options to test more advanced technology which includes GSM communications
- Substantiate assumptions required for the development of the business model and workshop this with Council
- Subject to the business case evaluation and Council approval, gradually implement AMR as a complimentary initiative whilst implementing the water meter renewal project
- Explore various funding options as well as the opportunity to partner with other services e.g. electricity and gas, garbage removal
- It is proposed that a site visit be arranged to one or more Australian installations which will provide TCC with the opportunity to investigate the realities and benefits first hand.

Other Councils who are considering implementation of water metering and/or AMR have expressed interest in TCC's findings on the pilot project. As TCC is leading investigations in New Zealand, it would opportune for TCC to share findings perhaps through a national forum such as Water New Zealand to share findings and experiences.

In conclusion, the pilot project has indicated that the benefits of AMR/AMI reach far beyond pure economics of meter reading. Other benefits include accuracy of information, a mechanism for applying tariff structuring alternatives, improved demand management, H&S considerations, improved customer services, a means of future-proofing our present investment in universal metering and contributing to the present demand management initiative.

2 Introduction

2.1 Background

Universal metering has been adopted and implemented by Tauranga City Council (TCC) for reasons of equitable billing for water consumed as well as improved demand management. Approximately 46,000 domestic meters have been installed since the year 2000. Consumer billing, based on measured consumption commenced in July 2002.

TCC is developing a demand management protocol which will promote water balancing, water conservation and non-revenue water management. The accuracy and value of these initiatives will depend to an extent on the accuracy and frequency of meter readings. As a part of this process, TCC have developed a water meter renewal strategy and program which considers throughput, age and economics.

AMR is gaining popularity internationally as a means of efficient, accurate and cost-effective meter reading. The peripheral benefits of AMR are also gaining recognition in demand management circles e.g. backflow and leakage alarms, more frequent and timely readings for water balancing, consumption profiling etc. AMR was therefore considered an attractive supplementary initiative and discussions were held with three vendors who have a local presence (names have been excluded from this report for reasons of confidentiality and impartiality).

Various trial sites were established and (loosely) monitored. In March 2008, it was decided to formalise the AMR pilot study. A brief was issued to the three vendors and additional equipment procured and installed in various gated communities and other locations. A total of 228 meters were fitted with AMR "transponders" for the trial and regular site reads and meetings were initiated to monitor progress and results.

The pilot project is now complete. This report consolidates the findings, evaluates the technology and provides a business case for consideration.

2.2 Objectives of AMR Enquiry

The scope of the pilot project and expectations were documented and provided to vendors in an enquiry which is appended for reference (Appendix A). In short, the objectives of the pilot included the following:

a. Assess the functionality of proposed system(s)
b. Assess the compatibility of vendor solutions towards an integrated TCC solution
c. Assess the software and back-office implications for TCC
d. Develop a business case/model which would explore the economics of AMR and feasibility as a solution for TCC
e. Propose an implementation strategy to council.

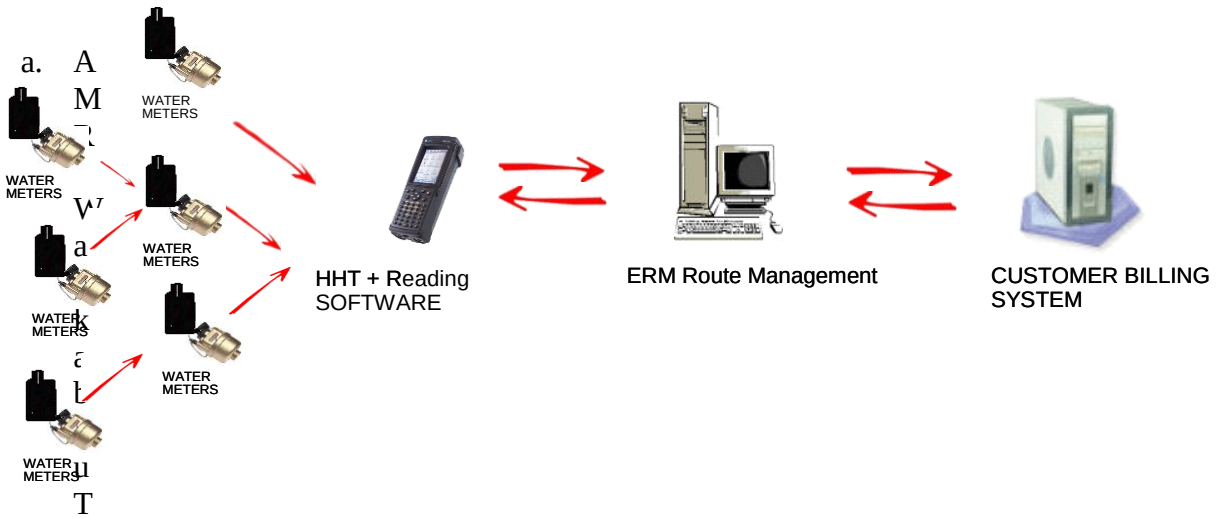
2.3 Technology Overview

Background research was conducted and an earlier report (*AMR Report*, March 2008) was presented to management which outlined technical options and approximate costs. Further discussions with suppliers and media research indicate that three basic AMR options are commonly available, namely walk-by, drive by and AMI.

2.3.1 AMR

The basic components of AMR technology are illustrated in the following diagram.

Figure 1: Typical AMR Architecture



The AMR process comprises the uploading of meter reading details and walk routes from the billing system onto a ***hand-held terminal (HHT).*** Meters are equipped with ***transponders*** which register pulses generated by the meter. When the HHT is in close proximity (e.g. 5 m to 150m depending on circumstances) to the meter, it communicates (handshakes) with the meter and uploads/ its current reading and other flags (alarms such as tamper, leakage, backflow). This encoded information is downloaded from the HHT to the master station (PC) where reports are generated and bills prepared in the normal manner. Miss-reads and errors/flags (backflow/leak/tamper) and other information can also be recorded and reported. Meter reading distance and reliability depends on the location of the meter (within the meter box, proximity to obstacles or buildings etc) and usually varies from 10m to 1km (line of sight). Radio frequencies (**RF**) vary from 400 MHz through 900 MHz – vendors have adopted different frequencies to suit their needs. RF repeater stations which convey information by "leap-frogging" data across a series of signal boosters (***repeaters***) to a base station are a good option for gated communities where signals can be relayed to the front gate for ease of reading a large number of meters from one location. Information is uploaded to the master station (TCC billing system in this case) from HHT's.

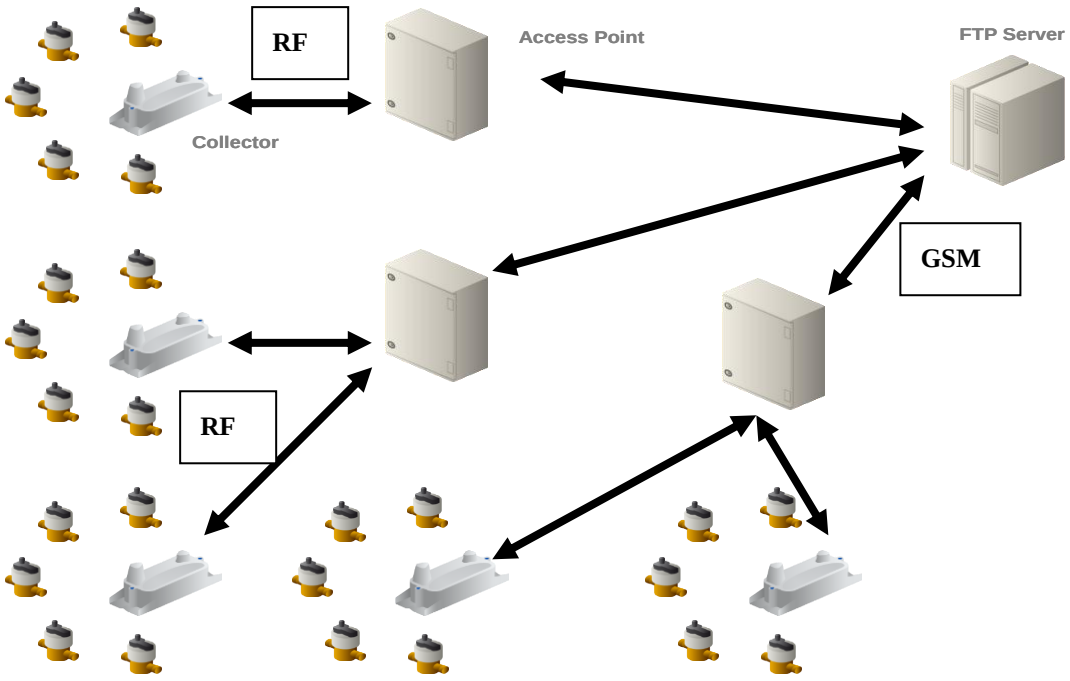
b. The alternative to the above is a ***drive-by*** process which incorporates the HHT being attached to vehicle, usually equipped with an external antennae. Reliability of reads depends on the vehicle speed and installation criteria mentioned above.

2.3.2 AMI (GSM/GPRS)

An alternative option, ***automatic meter infrastructure*** (AMI) comprises the communication of information directly from the meters using radio frequency to various collectors followed by transmission of information via an appropriate gateway using GSM (Global System for Mobile Communications) /GPRS (General Packet Radio Service) protocol to a master station at utility headquarters for processing and

billing. Meter reading can be undertaken as frequently as required but it is usual to undertake daily interrogation to pick up leakage and backflow events, occasional hourly profiling for diurnal usage and night-flow analysis) and less frequent interrogation for meter reading and billing purposes. Whilst this option requires slightly more extensive infrastructure and incurs communication (GPRS) costs, benefits include the virtual elimination of meter reading costs and leakage and other alarms can be reported on the day they occur, providing improved customer service and leakage management and reducing health risks from backflows substantially.

Figure 2: Typical AMI Architecture



2.3.3 Code of Practice Requirements

It should be noted that a requirement in the Metering Code of Practice (which is a guideline) is for meters to be read at least once per year manually. This is an issue that could impact on the business case and the need for this should perhaps be reviewed in the appropriate forum. As an example, the guideline could perhaps include the manual reading of a sample set whilst the technology is relatively fresh, and reviewed in due course as more experience is gained with smart metering.

3 Pilot Project Planning and Implementation

3.1 Briefing of Vendors and Preparatory Work

The three participating vendors (not named in this document for reasons of commercial confidentiality) were briefed regarding the objectives of the pilot study, TCC's expectations, anticipated participation as well as required monitoring and reporting procedures and requirements. A draft report and monitoring checklist was issued for comment and generally accepted. The aim of that document was to provide a basis for comparing functionality and

performance of the three vendor's products across three areas of interest namely, software, transponder and HHT and that the implications for TCC (back-office, administration) would also be assessed.

3.2 Project Plan

AMR transponders were installed/upgraded prior to and during June 2008. Four *read* events (i.e. reading meters using AMR HHT's) were conducted – 1st July 2008, 1st August, 5th September and 3rd October 2008. Read events were each preceded by a manual read by TCC staff of all meters included in the pilot. This was done as a volumetric check of accuracy. TCC staff accompanied vendors on the first read to witness procedures and on the last read to test pre-set flags (tamper and backflow). The first and last read was conducted jointly with TCC staff to witness practicalities, challenges and read rates whilst the others were undertaken independently by vendors. Vendors were encouraged to establish repeaters/ groupings for the last read to demonstrate the potential to improve efficiency of reads.

3.3 Pilot Sites

Various gated community sites were selected for the pilot project as they enabled reading and monitoring in close proximity to each other and were also believed to be attractive options for AMR consideration. However, in order to test the technology in other situations, various other independent sites were selected including the Mount Maunganui CBD and an industrial meter. A spread of the three vendors' meters and transponders were installed for equitable comparison. In total, 228 meter and transponder assemblies were installed.

3.4 Specifications of Vendors Equipment

Specifications and details have been omitted for vendor confidentiality reasons. However, it suffices to mention that three different combinations of meter-transponder-HHT equipment and a range of frequencies (400 – 900 MHz) were trialled.

3.5 Specific TCC Requirements

During the briefing, the following specific requirements were noted by TCC (complimentary to the briefing document):

- Transponder and HHT
    - Alarms were to be reported as well as read results. Alarms include leakage (defined as flow not dropping below a threshold of 10l/hr for more than 1 hour in the day), high flow, backflow and tamper
    - Vendors were requested to develop appropriate interfaces that would enable all transponders to be read by their HHT i.e. TCC will endeavour to eventually use one HHT for all reads. Only one vendor was able to comply with this requirement. Others have however undertaken to address this in future.
- Software - It was originally intended to have each of the vendors communicate with the TCC billing system (Origen) via the present interface software (MeterOr). However, due to challenges and potential costs of writing specific software interfaces, it was decided to allow vendors to confine their data uploading and downloading to their proprietary software and to demonstrate reporting capabilities at that level. The proviso

was that an undertaking be given to TCC to write specific interfaces in the event of AMR implementation in TCC.

3.6 Scoring and performance rating

Vendors were advised that score sheets would be used as a guide to comparing performance of the proposed products and contributed to a scoring template. Scores were recorded by the TCC monitoring team for performance aspects relating to software, HHT, transponder, robustness and communications. Results were recorded for each read event as well as overall performance criteria. A formal debriefing session will be held with each vendor to discuss results, observations and issues requiring further attention (discussed later).

3.7 Meetings and Reports

Meetings were held following each of the field reads to share findings. Vendors were requested to report findings monthly, in an agreed format (for commonality) including extracts from their management system's output. Typical results included serial number, reading, volume consumed, date/time of read, flag/alarm (described above) detected, read rates and challenges.

3.8 Vendor Presentations and Documentation

During the pilot project, Vendors were provided the opportunity to provide detailed product information as well as referrals and business case materials. They also provided information regarding alternative options (e.g. AMI) and costs as a part of their final report. Key issues covered include:

- Management system functionality, user friendliness and reporting ability
- Transponder technology and functionality
- HHT options, software, display, robustness and functionality
- AMR technology available and enhancements to improve read-efficiency
- Future proofing considerations – AMI technology options, upgradability, architecture and costing model(s)
- Installations track record, experience.

Vendors were very cooperative and presentations and discussions that followed were informative and of benefit to TCC as well as vendors. Vendors were also requested to provide input to the development of the TCC AMR business case/model by providing approximate costs, case studies, references and recommendations.

4 Preliminary Results

4.1 Field Read Results

Detailed reports were provided by vendors and pertinent findings are summarised below.

- Accuracies – varied between 98% and 99% on a correlation test when compared with TCC's manually taken readings. Certain anomalies were experienced, mainly attributable to misalignment of serial numbers and addresses and, in one vendor's case, poor initialisation/ synchronisation of the first read

- Average read distance – varied from 5 m in a typical Tauranga suburb to 150 m in gated community – very dependent on installation, proximity to buildings etc., read vantage points
- Drive by reads were undertaken successfully in an industrial installation at 40 km/hr
- Read rates varied between 13secs and 80 seconds, including logistics (i.e. total time elapsed divided by number of meters read). Actual read times excluding logistics averaged between 3 and 10 seconds
- Where repeaters were installed (lamp posts etc.), read rate increased marginally, but was dependant on configuration of the interrogation
- Alarms (tamper, leakage, backflow) were recorded and reported by vendors during the project. However, the interpretation of alarms differed between vendors. Whilst only one vendor was able to successfully demonstrate all three categories, others have newer technology equipment available which will enhance certain capabilities e.g. inductive meter reading for backflow, but possibly not tamper (covered in more detail below)

4.2 Vendor Performance Rating

4.2.1 Scoring

Independent scoring was undertaken by the three TCC officials following the pilot project (in retrospect, during the pilot, as intended, would have been better). Whilst there is some subjectivity in the rating of software performance and interpretation of hardware performance, the results were found to be fairly consistent and acceptable. The results are excluded for confidentiality.

4.2.2 Vendor Support Assessment

This is considered a key element in the decision-making process. Whilst it was difficult to fully evaluate the expected support which vendors could offer, it was noted that fairly extensive technical support was required from international sources associated with some vendors in order to "fine-tune" the technology. Capabilities with regards to software enhancements varied from local to off-shore capabilities, with varying degrees of expected turnaround time.

4.3 Vendor Installation Base

Vendors were requested to provide details of local and installations as well as provide references for TCC to follow up. Whilst numbers cannot be disclosed in this report, it suffices to say that less than 2 million water AMR devices have been installed by the vendors internationally, less than 100 000 in Australia and less than 1000 in New Zealand. The latter comprised mainly installations with difficult access, bulk meters and pilots such as Tauranga.
Technical Evaluation

5 Technical Discussion

5.1 Transponder – Meter Combination

5.1.1 General Issues

a. Two vendors used meters with inductive read capability whilst the third deployed meters with reed switch capability – the latter has subsequently offered upgraded technology that accommodates inductive reads as well

b. On vendor provided a clip on transponder which allowed tamper detection on removal (depressible button) whilst the other two used wired transponders which limit tamper capabilities to wire cut or plausibility checking (fit within specified tolerances e.g. flow rate threshold.

The wired transponders would require higher skill and more effort on an in-situ retro-fit and would also require water proofing of any joints (to protect the integrity of the IP rating). A preferable option for both would however be a factory pre-configured "plug and play" unit (meter and transponder) which could be installed as a part of a meter renewal program.

It should also be noted that some vendors offer transponders that can be wired to 2 or 4 meters which could contribute to a more cost effective solution once specific site requirements are known but would increase installation costs.

5.1.2 Tamper

A non-permanent tamper was interpreted as a temporary tamper that is recorded but enables the unit to continue functioning. A permanent tamper creates a functionality problem and prevents the unit from working without further intervention. As mentioned above, only one unit incorporates a clip-on transponder with a *depressible* button which records a non-permanent tamper event. Other units rely on communication cables to be severed or plausibility checks e.g. 10% below of an expected minimum.

5.1.3 Leakage

All vendors were able to achieve this requirement either directly or by plausibility checks but the consistency of identification varied.

5.1.4 Backflow

Meters which utilised inductive pulse technology were able to adequately record backflow events.

5.2 Read Rate

Read rate and read distances were probably the most important and most monitored factors and varied substantially between vendors and sites. Generally, read rate and distance was found to be affected by:

- Proximity to buildings, trees and obstructions
- Installation depth in the meter box all TCC meters are buried meters, except certain bulk and industrial meters

- Type of meter box lid – steel in the Mount CBD, plastic elsewhere
- Vantage point (location) of meter reader.

Research indicates that AMR read rates could be reduced by up to 70% of the time taken for manual reads. Read rates achieved on the pilot were not significantly lower than read rates experienced by meter readers, currently manually recording readings on HHT. There were exceptions but generally read rate was not as good as originally expected. The reasons for this are considered to be as described above, but primarily due to poor configuration and setup.

Various attempts were made to improve this, some successful (vantage point optimisation), others not (repeaters). Further work is required with vendors to improve this factor by trialling different configurations, raining repeaters, changing vantage points, upgrading technology etc.

5.3 Integration between Products

Only one vendor successfully demonstrated the ability to provide appropriate interfaces that enabled them to read all three transponders with one HHT albeit with an adaptor to convert signals relating to a different frequency. Whilst this was encouraging, it highlighted a challenge in the industry relating to the lack of a common communication platform (standard). This would facilitate a more sustainable solution in that it would provide users the option to deploy a mix of technologies and reduce "vendor-dependence". The latter was a point raised in communications with Australian AMR users.

5.4 Management System

Vendors presented their software functionality to the TCC team and also used it to generate reports during the pilot project. The software has not been used sufficiently by TCC to enable a conclusive evaluation but it suffices to comment that the perceived capabilities are appropriate for TCC purposes. Vendors generally offered two versions of software. The more sophisticated is geared for advanced (and AMI) functionality and reporting (at a cost) whilst the more rudimentary versions, generally free or for a nominal cost, was presumably designed to provide basic functionality and reporting ability necessary to support the product.

5.5 Hand Held Terminal (HHT)

Hardware configuration on the three hand-held terminals (HHT's) used by Vendors ranged from touch screen to keypad functionality. Functionality on each HHT varied, dependant on vendor-specific software. The configuration settings on the HHT proved to be very important - the most effective configuration appeared to be the interrogation of small groups of meters on a walk route rather than one large group and halved the read time required in most cases. As reiterated by existing users in Australia, it will be in TCC's interest to standardise the firmware and future proof the technology by rendering the solution vendor-independent.

5.6 Independent TCC Evaluation

In order to test the reported read rates and findings, TCC undertook an independent field evaluation using HHT's on loan from vendors. As expected, read rates varied significantly from site to site and per vendor e.g.

- The Mount CBD provided a read rate of approximately 3 seconds from distances varying from 5 m to 100 m despite steel manhole lids

- Gated communities provided varying results. In one case 95% of meters were read from a few optimised locations within 20 minutes including some readings undertaken from 150m and no direct line of sight. This compared favourably with manual read rates but not as well as read rates reported by international users. Further assessments were undertaken on other gated communities with less favourable results, particularly as a result of non-optimal configuration and setup of repeaters

- A drive-by test was performed satisfactorily by reading a factory meter at approximately 40 km/hr from approximately 150 m

Further trials are still being conducted by TCC staff and will be discussed with vendors on an ongoing basis.

5.7 Residents Perception

A few enquiries and comments were received from residents – mainly observations and positive response to the proposed technology.

6 Case Study Findings

Vendors were requested to provide information on previous installations, case studies and experiences as well as a reference list of present users that could be approached. The following is a summary of presented information and findings following discussions (yellow boxes indicate users that were called).

Table 1 Summary of Vendor Case Study Material Provided

Description of Project	*Drivers*	*Number & type of units*	*Benefits and comments*
User 1, Australia	Avoid estimates and manual errors, water shortage	50,000	Improved accuracy, reduced no-read rate to 0.7%, cautioned against vendor dependence
User 2 Australia	Reduce no-reads	3,000	No-reads reduced, undertaking a AMI trial
User 3 France	Increased tariff, consumer driven to reduce estimates and increase accuracy	250,000	Efficiency, time saving, reduced *no-reads*, increased billing frequency, non-invasive reading, track and reduce wastage and losses
User 4 Australia	Locked gates on complex	Unknown	95% customers bought AMR
User 5 Australia	Untreated water – backflow prevention	Unknown	Monitor backflows and respond to incidents
User 6 USA	Accuracy and efficiency, financial, reduce estimates from	75,000	Cuts meter reading from 7 hrs to 15 minutes, increased billed consumption by 7%, part of

Description of Project	*Drivers*	*Number & type of units*	*Benefits and comments*
	10%		meter renewal program
User 7 USA	Accuracy and efficiency, financial, reduced estimates – part of renewal (25yr old meters) program	125,000 transponders and 70 data collectors	Cuts meter reading from 7 hrs to 15 minutes by utilising drive-by reading, increased billed consumption by 2.5%
User 8 USA	Less resource intensive, faster to read, tested walk by and drive by and opted for latter	40,000	3 pilots – HHT to walk by to drive by. Retained same number of staff and vehicles instead of increasing
User 9 USA	Reduce UFW and reduce read time, increase accuracy	88,000	Reduced UFW by 2.7% in 3 months (project $3m savings), reduced call volumes by 52% & meter work orders by 90%
User 10 Germany	Replace manual read of 35,000 meters, retro-fit in hard to read locations	(Fixed network)	?
User 11 UK	Handle future tariff structures, efficiency, accuracy	(Fixed network)	Targeted multi-occupancy developments

7 Cost Estimates

As requested by TCC, vendors provided informal technical proposals for AMR products which were piloted, including budget costs and economy of scale considerations. Vendors also provided additional information which considered future proofing of the proposed TCC investment including AMI. Please note that costs exclude retrofitting and field installation as this work would probably be undertaken by a combination TCC staff and/or local contractors with appropriate skills.

Two vendors offered multi-unit (2 or 4 meters per transponder) options. Due to uncertainty of the required architecture and layout of AMR implementation, this was not considered in the costing. However, costs can be substantially reduced by incorporating this option where appropriate during implementation.

Two vendors offered clip-on and (alterative) wired transponder connections. Whilst the latter provides the option for mounting under the meter box lid, it requires labour to do so and the IP rating could be jeopardised if the cable connections do not remain watertight.

The following table illustrates the range of prices received.

Table2 Indication of AMR Price Range Received (rounded)

Item	*Average Price (NZ$)*
Meter	65
AMR Transponder (clip-on)	135
Combo (meter & transponder)	190
Repeater	420
HHT (excl. SW & Maint)	6000

Assumptions - The above are based on quoted figures for 10000+ units which represent the *keenest* price category in the informal inquiry. A clip-on transponder assembly has been assumed in conjunction with inductive (OIML compliant) metering for comparison and as this is likely to be the preferred option in future.

8 Benefits of AMR/AMI

The following has been derived from extensive research and discussion with users and vendors.

There are various benefits which can be realised by implementation of AMR/AMI. Whilst some of the benefits such as efficiency of meter reading, accuracy, leakage detection are obvious, others such as improved customer services, delayed expenditure are less obvious and not as easily quantifiable. The following is an attempt to illustrate the various benefits which TCC could expect to derive by implementing AMR.

Figure 3 AMR Value Add and Touch Points

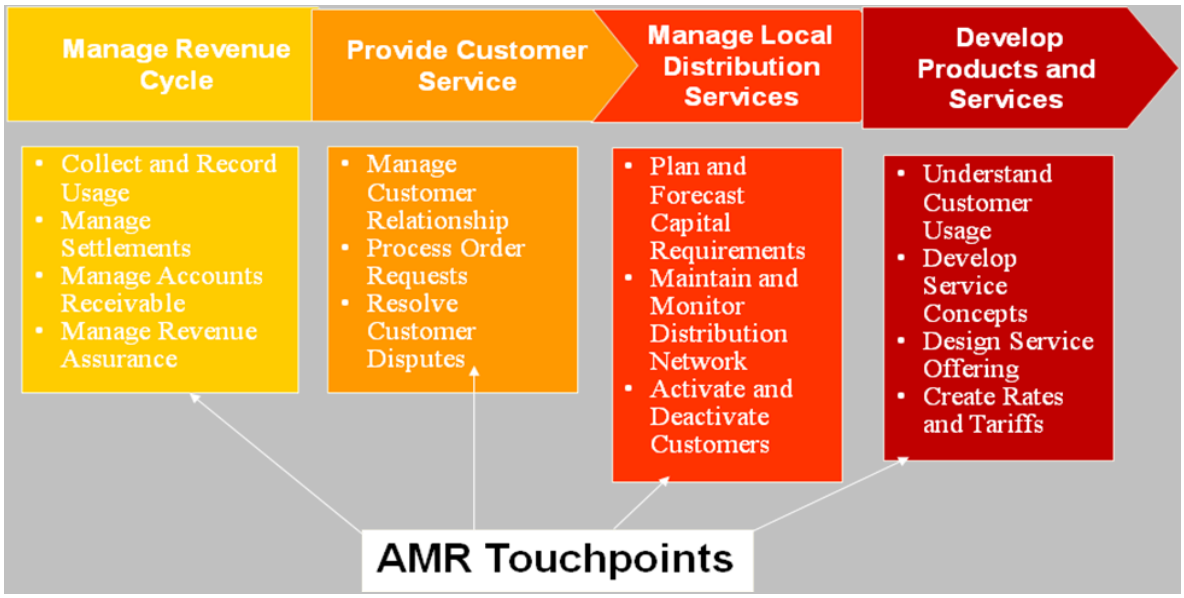


Figure 3 illustrates the value-add opportunities predominantly across customer services and commercial activities. There are additional touch points which include infrastructure management, non-revenue water management, water conservation and customer education,

communications and participation. These are not easily quantifiable but have an indirect impact on capital and operating costs as discussed below.

8.1.1 Tangible Benefits

- Improved meter reading and billing accuracy and efficiency resulting in , reduced estimates, reduced reading costs (per meter), improved revenue stream
- Reduced operational and administrative costs relating to customer queries and complaints and follow-up. Associated with this is improved customer feedback regarding comprehensive consumption and leakage information

8.1.2 Less Tangible (difficult to quantify) Benefits

- The present water demand management initiative has highlighted the need for more regular and accurate water consumption and supply information for water balancing and NRW prioritisation and management. This would require more regular meter-readings and would also need to be supported by consumer education and communications in order to gain appropriate participation in reducing wastage and leakage
- H&S issues could be avoided by regular monitoring and reaction to backflow events. Recent examples of backflow at AMR installations in the port have illustrated the benefit of AMR in this regard
- As a result of reduced leakage, the expected life of existing assets including purification, storage and distribution could be extended, resulting in delayed capital and operational expenditure
- More regular and comprehensive consumption information will facilitate any proposed initiatives to impose stepped and/or seasonal tariff charges. The latter has been identified as a means to reduce peak water supply. This would also provide TCC with an opportunity to negotiate with industry regarding peak usage mitigation (e.g. on-site storage, time of use charges).

9 Business Case Development

A preliminary economic evaluation indicated that the present worth cost of AMR implementation does not compare well with present conventional meter reading practices. However, some of the cost savings and benefits were not factored into the analysis as they required further evaluation.

Research has also highlighted that meter reading is not a standalone reason for adopting AMR but that many issues need to be considered in a business case evaluation – these are outlined in Table 3 below.

Table 3Parameters for Consideration in the Economic Model

Parameter	*General Impact*	*Specific to TCC*
Drivers for change (cost reduction, conservation of scarce resource, accuracy etc.)	Affects the choice (and cost) of functionality and infrastructure required to achieve results e.g. AMR or AMI	TCC has various drivers, including water demand management (proposed new Waiari water supply scheme capital deferment), H&S (backflow), leakage reduction, customer service
Price and of water and tariff structure	Higher cost enables quicker cost recovery through leak and wastage reduction	Fixed tariff at present but stepped/ seasonal tariff may be further explored
Frequency and cost of meter reading	More frequent readings required for demand management, leak reduction and backflow monitoring	TCC meters are read quarterly but would be required more regularly for improved water balancing, leak reduction, backflow identification. Billing frequency could however be increased or remain the same.
Installation, layout	Reading efficiency and/or requirement for additional infrastructure e.g. repeaters	TCC meters are buried, reducing read efficiency so strategically placed repeaters and/or reading vantage points are required
Type & Cost of AMR transponder	Variety available, 433 – 900 MHz, costs vary a lot	Cable and clip-on options are available – risk vs. cost
On-site water loss, wastage	On-site (after the meter) losses can only be identified by logging or using AMR technology	Perception in Tauranga is that water is *cheap*, reducing incentive to conserve water or repair leaks – education and tariff adjustment could assist with addressing this. Must also consider that impact of reduced wastage and leakage on the revenue stream.
Administration costs	Costs should reduce due to reduced queries as a result of improved accuracy of readings. Also consider the further benefit of additional information being available to consumers	Difficult to estimate savings although other report these

Although benefits are clearly understood and demonstrated above, the estimated parameters and savings effecting the evaluation of the business case proved difficult to quantify in some cases. For example, in order to quantify savings relating to infrastructure upgrading (treatment, storage and conveyance), AMR's contribution to water demand management reduction, over and above supply-side initiatives (reducing pressure, bursts etc.) would need to be estimated and apportioned. A further example is the difficulty in apportioning/ estimating back-office/administration savings and improved customer services reported by users.

Discussions were held with various Australian users regarding their experience with AMR and the drivers for the implementation of this technology. The drivers varied substantially but generally related to improved water demand management (water is very scarce in many areas), increasing the frequency and accuracy of information for demand management and improving customer feedback. Although AMR has proven itself, the cautionary note offered by users is that the economics do not stack up on a stand-alone meter reading efficiency basis – what is required is a holistic evaluation of all the drivers and benefits. A further note of caution was to avoid being *vendor dependant*, specifically as regards firmware and supporting software.

Whilst the drivers are not only cost related, it is essential that the economics should be better understood and that the long term investment options for TCC be quantified in a business model. It was therefore decided to further explore operational and back-office implications and benefits further to properly evaluate the business case in an operational environment before making final recommendations to Council and sharing economic findings with other interested councils.

10 Discussion and Recommendations

10.1 Achievement of Objectives

The various objectives stated in section 2.2 have been achieved with varying degrees of success:

a. Functionality has been fully explored but not fully demonstrated by all vendors

b. Compatibility between vendor solutions was not satisfactorily demonstrated but discussion with existing users highlighted a need to consider a vendor independent solution to future proof investment

c. Whilst admin implications are perhaps clearer, the reported admin savings (by current users) need to be quantified in an operational environment

d. The business case/model has not been finalised due to various key assumptions relating to costs and interpretation of savings and benefits which requires further investigation

e. Further work is therefore required before a firm strategy can be recommended to Council.

With reference to the objectives listed in the original enquiry (appended), TCC have generally gained valuable experience and knowledge regarding the available technology. However, the pilot project also provided local vendors with the opportunity to explore the functionality of their products and there is room for optimising product performance.

10.2 Further Investigation

The pilot project has highlighted issues requiring further investigation. In order to further evaluate the technology and issues affecting the business case, it is recommended that the present pilot be extended but with specific objectives relating to gaps in technology and economic evaluation identified above.

a. The present installations and infrastructure need to be work-shopped with vendors to provide a more efficient solution, largely by improving configuration of software/ reading setup, read rate, drive-by options and event reporting

b. The gated communities fitted with AMR should be optimised and used as operational sites to test the practicality of AMR implementation for operations as well as billing purposes. This will provide an opportunity to test the assumptions made in the economic model relating to read rate, admin savings, leak reduction and revenue stream

c. Vendors have also suggested AMI be setup for trialling (possibly at a subsidised rate) and this should be explored

d. Further analysis can be undertaken to ascertain what savings in capital and operational expenditure can be apportioned to AMR.

Whilst the present initiative has proved to be extremely informative, it has highlighted a few areas requiring a better understanding of practical application and a visit to various international users has been suggested to get first hand experience and feedback from their experience with AMR and AMI applications.

Following (or in parallel with) the above, the business case will be evaluated as a supplementary (not sole) motivation for implementation of AMR. Results from this pilot could be shared with other councils who are seeking guidance.

10.3 Business-as-Usual Installations

Notwithstanding the above, there are locations such as difficult (and/or dangerous) locations where the application of AMR technology is a logical option (accessibility, accuracy, H&S). This is considered as good practice ("business as usual") and should be implemented where necessary. Further consideration could be given to implementation of AMR at additional commercial and industrial (and/or large consumer) sites.

10.4 TCC Meter Fleet Renewal Considerations

Various councils in New Zealand are considering the advantages of Smart Metering as a part of the strategy for new meter installations or supplementary to their renewal program. As indicated from the informal pricing offered on this pilot, vendors are offering attractive combined packages (meter and AMR) and it is likely that this will become the accepted norm in future.

TCC's meter fleet is maturing and a strategy has been adopted to renew the existing meter fleet over a 10 year period resulting in an expected meter lifespan of between 12 and 20 years, dependant on throughput and economics. Failure rates are being monitored and, as/if tariffs are increased over time, the economics may require a review of the renewal strategy.

Considering the above, it would therefore be prudent to use the opportunity to adopt a water meter renewal strategy that also considers value-add benefits of AMR implementation, described above, during the process, given an agreed business case.

10.5 Future Proofing

AMR technology is fairly new to NZ and there is a requirement for *robust* and reliable (not cutting edge) technology. However, the technology is developing and improving rapidly and there is a need to future proof investments in this regard e.g. initial AMR investment upgradable to AMI by incorporation of GSM gateways. This supports a case for considering leasing and/ or partnering with a supplier OR engaging an annual renewal policy.

AMR and AMI technology is changing rapidly and, as more options become available technology is likely to become increasingly more cost-effective.

10.6 Council Approval

TCC are setting the pace with regards the investigation of AMR technology and evaluation of a business case in New Zealand and this has attracted interest from other councils who are considering the same. The findings of this pilot project should be workshopped with Council as a part of the demand management strategy to illustrate the key tangible and indirect benefits that could be derived from AMR implementation. Given an acceptable business case, a final motivation could be put to Council for approval and consideration in the 2010 annual plan submission.

10.7 Funding Considerations

The funding for the renewal of the existing meter fleet has been provided for in the 10-year plan and amounts to $5.6m over the next 10 years. However, no provision has been made for installation of AMI/AMR en-masse. Notwithstanding the fact that suppliers have offered very attractive pricing for the combination of meter and transponder, various options would need to be explored to fund this activity, should council approve in principle to proceed:

- Use of this technology towards a national demand management initiative (National Policy Statement) may open up an opportunity to apply for some form of Government subsidy, particularly as we are leading the pack and others could benefit from our experiences
- Leasing of units and service from vendor and/or partnering options
- Partnering/ combining with other services such as gas and electricity, particularly if data was being collected and transmitted via common gateways. AMR reading utilising garbage trucks could also be explored but would depend on read efficiency and rate as determined in phase 2 of the pilot as suggested below.

10.8 Phased Approach

Subject to business case evaluation and Council approval, a phased approach would be prudent and the following is suggested:

Table 5 Proposed Phased AMR Implementation Approach

Phase	*Description*	*Timing*	*Comment*
1	Large consumers (Commercial, Industrial) and difficult to access sites	Ongoing	Business as usual
2	Extend existing pilot, optimise and *operationalise* them	Between may 2009 and January 2010	Document and workshop with council as part of WDM program. Present final business case to council in time for 2010 annual plan submissions
3	Select one or more AMI sites in addition to existing pilots	Between may 2009 and January 2010	Expect/negotiate partial subsidy from vendors
4	• Gated communities • Balance of TCC area, in conjunction with renewals program	2010/2011 2012 +	Greenfields installations could include compulsory participation – would require Code/ District plan update
5	Tariff structure, education, customer services	Ongoing	Combination of initiatives with various TCC projects needs coordination

11 Conclusion

The AMR pilot project has been hugely beneficial in demonstrating the technology as well as the challenges that perhaps weren't as obvious at the outset. It has also indicated that the industry has a bit to learn about the application and optimising of the technology which is still in a state of change. The pilot has indicated that the benefits of AMR/AMI reach far beyond pure economics of meter reading and include accuracy of information, improved demand management, H&S considerations, improved customer services, mechanism for applying appropriate tariff structuring and a means of future-proofing our present investment in universal metering.

Appendix A - Copy of Original Enquiry

Automatic Meter Reading

Criteria for Testing Potential System

TCC are investigating the opportunity to implement AMR technology which will be supplementary to or in lieu of the present water meter and meter reading/billing strategy. In order to properly assess the options available in the industry, and to make a properly informed decision, TCC have invited various vendors to provide information which would address certain basic requirements. This basic information required from vendors is as follows: (supplementary information may also be provided):

1. The system must be compatible with our current meter types (i.e. Kent, Actaris, Sensus, Magflow and combination meters) for residential, commercial, industrial and bulk monitoring applications
2. The system must be compatible with our Origin billing system and/or databases such as SQL, Oracle
3. The vendor should outline its strategy and capacity to provide system support and technology/ software upgrades
4. Vendors should state how upgrades of AMR devices are catered for (plug in modules, replacement of components etc.)

The field installations should be weather proof in terms of full functionality including reading and transmission – (please state IP rating)

5. System security and warning parameters and strategy must be stated e.g. safeguard against vandalism and tampering, battery level and/or system failure.
6. The system should allow either of the following or all (please state).
   - Drive-by
   - Remote transmission
   - Dial-in

Note: this assessment to include distance and reliability of reading capability

7. Specify and maintenance requirements and consideration to possible weekly readings
8. State the versatility and implications of changing interrogation and transmission cycles
9. List reference sites using systems, when they were installed, number installed, experience on that site and contact details of referee
10. Provide a cost-benefit proposal accounting for at least the following:
    - Whole of life cost breakdown assuming a 20 year lifespan
    - TCC will still require one annual audit reading
    - Water tariff of $1.3 per m3
    - Cost to read meter xxx $/meter
    - Cost to process and send bill to customer xxx$/meter

Trials to be carried out over a 6 month period commencing 1 March 2008, and the submission of the results is to be forward to the General Manager, City Waters within 30 days of the completion of the trial.

Appendix B

Locality Map and Details of pilot units

X:\Engineering & Project Services\Project Files\EPS0115-00 - Automatic Meter Reading (AMR)\Pilot Project\Plots

Appendix C: Scoring Sheets (Sample)

AMR Pilot Performance Rating

Vendor: XXX

Evaluator: Combined

Date of Evaluation: 16th January 2008

Evaluators Guideline

1	The purpose of the document is to evaluate the AMR technology, functionality, software, interfacing/ compatibility and practical field application as well as the impact it has on the TCC "back-office". A separate document outlines specific requiremnents whilst this checklist provides a means of fair and equitable evaluation of AMR options being considered.
2	**Rating Guideline: Use the following on the SCORE SHEET (unless a specific guide is given for the item):** Excellent (Surpasses expectations) **5** Good **4** Acceptable (Meets TCC expectations) **3** Poor **2** Unacceptable (does not meet TCC expectations) **1**
3	The **upfront** score sheet is a one off relating to compatability and software issues. The **monthly** sheets are to be completed after each monthly read
4	Expectations and evaluation criteria should be clarified at the start of the pilot evaluation

Rating - Upfront Score Sheet

Form	Rating Factor	Vendor 1	Vendor 2	Vendor 3
A	AMR Transponder			
B	Hand Held Terminal			
C	Master station			
D	General (report, support)			
	TOTAL			

Rating Month 1

Form	Rating Factor			
A	AMR Transponder			
B	Hand Held Terminal			
	TOTAL			

Rating Month 2

Form	Rating Factor			
A	AMR Transponder			
B	Hand Held Terminal			
	TOTAL			

Rating Month 3

Form	Rating Factor			
A	AMR Transponder			
B	Hand Held Terminal			
	TOTAL			

Grand Totals

Rating Factor	Vendor 1	Vendor 2	Vendor 3
Rating - Upfront Score Sheet	0.0	0.0	0.0
Rating Month 1	0.0	0.0	0.0
Rating Month 2	0.0	0.0	0.0
Rating Month 3	0.0	0.0	0.0
Overall	**0.0**	**0.0**	**0.0**

Appendix D
SWOT ANALYSIS - AMR

	AMR
Strengths & Opportunities	Improved meter reading efficiency and accuracy Reduced meter reading costs Reduced admin costs (consider the whole billing-customer service cycle) More accurate and frequent readings supports tariff structuring and WDM initiatives and could allow more frequent billing and improved cash flow for TCC Improved water balancing (frequency and accuracy) in support of WDM initiatives Leak, tamper and backflow detection "flags" which will, in support of WDM initiatives, enable more efficient leak reduction Promotes water conservation initiatives and improved customer information
Weaknesses & Threats	Flags and alarms only actioned after meter reads – monthly (as opposed to daily for AMI) Missed AMR reads will be flagged and will need re-visiting – importance of optimising the installations Technology is advancing rapidly and AMI could render AMR obsolete within 10 years Initial expense to implement is high but marginal cost needs consideration i.e. over and above meter renewal which is budgeted for