Smart Water Metering Cost Benefit Study

Final Report – Available for Information



Available for Information

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Intention of the Study

The focus of this work is on research and innovation and the discussion of possible scenarios based on current trends and practices in the utility sector. It is not intended to prejudge or indicate direction and seeks to stimulate discussion based on knowledge and facts.

As such the work is intended to provide input to and support for the development of future government policy but it should not be viewed as reflective of current or future policy decisions.

1 Background

1.1 Introduction

The Department of Sustainability and Environment (DSE) has undertaken a Study to investigate the potential costs and benefits of implementing smart water metering in Victoria. This Study was driven by:

- The need to respond to the variety of challenges arising from climate change, infrastructure investment and population growth;
- Increased interest of many electricity, gas and water service authorities across the world in smart metering;
- The opportunity to significantly improve delivery of the urban water services and enhance other water efficiency initiatives through increasing customer awareness of their water use, empowering customers to better manage their consumption and providing valuable demand information to the Victorian Urban Water Sector stakeholders;
- The need to evaluate whether smart water metering has the potential to play an important role in stimulating innovation in water management and the achievement of longer term Victorian water industry reform objectives; and
- An opportunity for the water industry to understand implications of the Victorian investment and capability of Smart Electricity Metering.

The DSE appointed Marchment Hill Consulting (MHC) to conduct this Study into the costs and benefits of implementing smart water metering in the Victorian Urban Water Sector.

This Smart Water Metering Cost Benefit Study – Report covers the following areas:

- This section (Section 1) provides the background, including relevant context for this Study and the Purpose, Approach and Methodology of the Study;
- Section 2 discusses the context of the Victorian Urban Water Sector, particularly the key themes and the relevance of smart water metering to the sector;
- Section 3 is a detailed description of the metering Implementation Options;
- Section 4 represents the quantitative analysis of the metering Implementation Options, particularly the results of the cost benefit analysis, the key assumptions and sensitivity analysis;
- Section 5 represents the qualitative analysis in relation to customer, societal, policy and environmental impacts; and
- Section 6 discusses the conclusions and recommendations of the Study.

1.2 Context: The Victorian Urban Water Sector

The Victorian Urban Water Sector is facing a set of issues which, in aggregate, are unprecedented and are making the entire sector an area of public and community focus.

These events include:

- A prolonged change in rainfall patterns and quantum, which has significantly diminished bulk water storage levels;
- Extended application of severe water restriction regimes as the primary tool to manage supply shortages;
- Debate around the effectiveness of current water tariff regimes at driving efficient water use; and
- Increased scrutiny on bulk water planning, water restriction policies and the price of water as a result of the above.

These events have driven an interest in identifying the potential for smart water metering to benefit the water industry and community.

1.3 Australian Electricity AMI Initiatives

Studies by the Victorian and Federal Governments have found that the potential benefits from implementing Smart Electricity Metering to approximately 10 million electricity customers across Australia will outweigh the costs.

The Ministerial Council on Energy (MCE) has commissioned the National Smart Metering Project to develop a national framework for Smart Electricity Metering. Prior to the MCE initiative, the Victorian Government, through the Department of Primary Industries, mandated the deployment of Smart Electricity Metering to all residential and small businesses in Victoria and delivery of a set of minimum Advanced Metering Infrastructure (AMI) Services to these consumers. The Victorian Government and participants in the Victorian electricity sector have established the Victorian AMI Program to deliver the Smart Electricity Metering and enable the AMI services.

The Smart Electricity Meters being deployed in Victoria are required to be able to connect to other devices within the customers premise via a Home Area Network (HAN) and to communicate between these devices and from / to the electricity distribution business.

In the context of the Victorian AMI Program, a water meter could be considered as a HAN device. Therefore, the opportunity exists for the water industry to leverage off this investment and capability to deliver benefits to the Victorian Urban Water sector.

Similar functionality is being considered in other Australian jurisdictions and may be included in the national framework developed by the National Smart Metering project.

1.4 Purpose of this Study

The purpose of the project is to develop a Smart Water Metering Cost Benefit Study that:

- Recognises the drivers and environment in which the urban water sector across Victoria operates;
- Considers the relevance of smart metering to the Victorian Urban Water Sector; and
- Analyses quantitative and qualitative costs and benefits related to the deployment and operation of smart water metering in the Victorian Urban Water Sector to determine if there could be a net benefit.

The outcomes of this Study will be used to stimulate policy discussion and consideration of next steps amongst a broad stakeholder community.

1.5 Approach and Methodology

The approach adopted for this Study primarily involved the continuous engagement of key industry stakeholders, either through industry forums, on-site interviews or teleconferences. The following key tasks were undertaken:

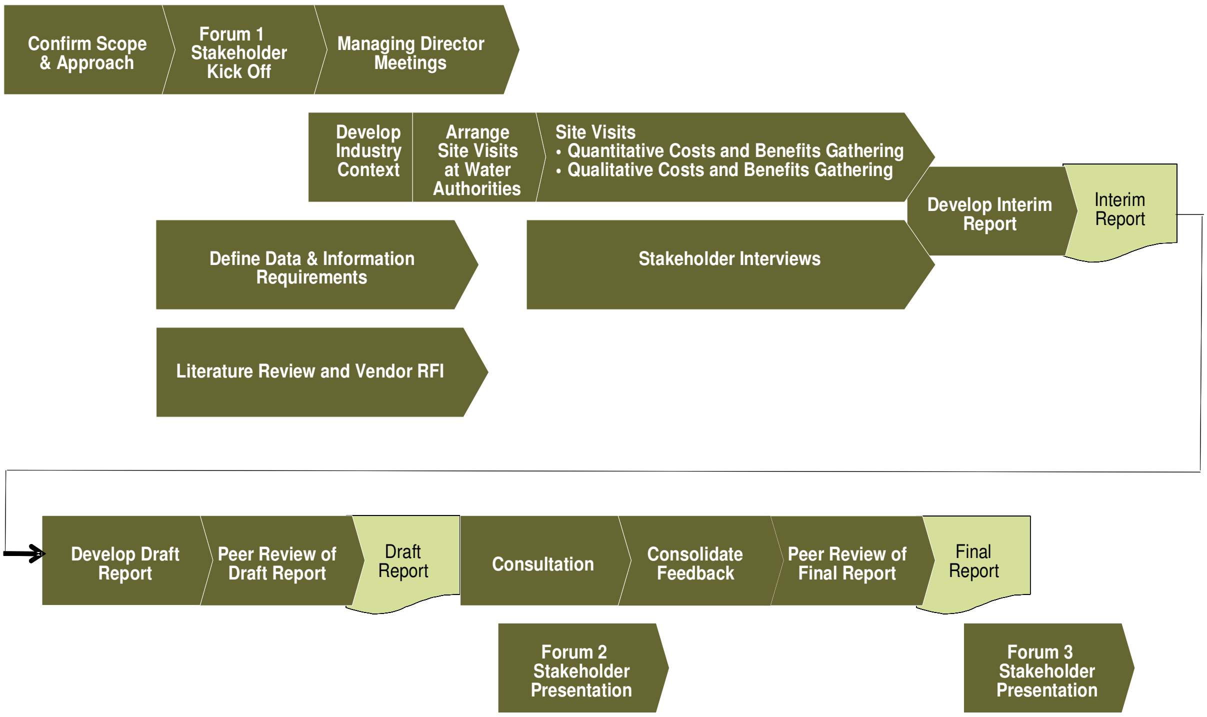
- Meetings with the Managing Directors and / or General Managers of the following Water Authorities[1];
    - South East Water;
    - City West Water;
    - Yarra Valley Water;
    - Melbourne Water;
    - Barwon Water;
    - Central Highlands Water; and
    - Coliban Water.
- Meetings with a number of key stakeholders from the Department of Sustainability and Environment (DSE), Department of Premier and Cabinet (DPC), UniWater, Water Services Association of Australia (WSAA), St Vincent De Paul Society, Essential Services Commission (ESC) and CitiPower / Powercor;
- Conducting site interviews with Customer Service, Asset Management, Regulatory and Sustainability representatives from the Water Authorities listed above;
- Using the meetings and site interviews to gain an understanding of smart water metering in the context of the current and future Victorian Urban Water Sector;
- Using the meetings and site interviews to collect data on quantitative and qualitative costs and benefits; and

[1] Throughout this report, we have termed these businesses “Water Authorities” rather than “Water Corporations”, to avoid any possible confusion with the Water Corporation of Western Australia.

- Conducting industry forums to introduce the Study and present the findings (note that two of three industry forums have been conducted to date).

The methodology adopted for the Smart Water Metering Cost Benefit Study is depicted in Figure 1 below.

Figure 1: Methodology Adopted for Smart Water Metering Cost Benefit Study



1.5.1 Confirm Scope and Approach

This step involved confirming the scope, approach, timeline and deliverables for the Smart Water Metering Cost Benefit Study with the DSE, and then preparing the relevant information for Forum 1 – Stakeholder Kickoff.

1.5.2 Forum 1 – Stakeholder Kickoff

The Stakeholder Kick-Off Forum was specifically targeted at informing a wide range of water industry stakeholders, including government, Water Authorities, associations, consumer groups and electricity distribution businesses, of the objectives, methodology and expectations of their involvement in the development of the Smart Water Metering Cost Benefit Study.

1.5.3 Managing Director Meetings

The purpose of the meetings with the Managing Directors / General Managers of selected Water Authorities was to gain some context of the current and future Victorian Urban Water Sector and the potential role of smart water metering in the sector.

1.5.4 Literature Review and Vendor RFI

A review was conducted of internationally available literature covering:

- Water Demand – Elasticity, Willingness to Pay and Scarcity Pricing;
- Water Industry Reform Options; and
- Smart Water Metering and Automated Meter Reading (AMR) projects, in Australia and Internationally.

The details of this Literature Review are contained in **Appendix A**.

1.5.5 Stakeholder Interviews

This involved conducting a series of interviews with key stakeholders from the DSE, DPC, UniWater, WSAA, St Vincent De Paul Society, ESC and CitiPower / Powercor to gain their context of the Victorian Urban Water Sector and the potential role of smart water metering.

1.5.6 Develop Industry Context

This step involved gaining an understanding of smart water metering in the context of the current and future Victorian Urban Water Sector. This was based on research and the outcomes of meetings with the Managing Directors / General Managers of the Water Authorities and the DSE, DPC, ESC, UniWater, WSAA and St Vincent De Paul Society.

1.5.7 Define Data and Information Requirements

This step involved identifying and defining the quantitative and qualitative data and information requirements that needed to be gathered from selected Water Authorities in order to support the costs and benefits analysis.

1.5.8 Site Visits

The purpose of visiting the Water Authorities was to capture the quantitative and qualitative data and information necessary to build a cost benefit model.

The quantitative data and information sought was in relation to the following areas:

- Meter procurement and installation;
- Communications installation;
- Systems integration;
- Process redesign;
- Customer contact;
- Billing and accounting;
- Credit and collections;
- Remittance processing;
- Back office;

- Meter reading;
- Field works; and
- Asset Management.

The qualitative data and information sought was in relation to the following areas:

- Customer impacts;
- Societal impacts;
- Policy impacts; and
- Environmental impacts.

1.5.9 Develop Interim Report

An Interim Report was developed to provide the DSE with insights on the key findings of the Study, particularly whether the analysis conducted to date was indicating value to continue with the Study in relation to the implementation of smart water metering.

1.5.10 Develop Draft Report

Once the Interim Report was approved by the DSE, a Draft Report was developed.

1.5.11 Peer Review of Draft Report

The purpose of the Smart Water Metering Peer Review Group is to ensure a considered Cost Benefit Study, covering quantitative and qualitative costs and benefits, is developed based on input from industry stakeholders. The role of the Smart Water Metering Peer Review Group is to:

- Review the key elements of all quantitative and qualitative assumptions associated with the Smart Water Metering Cost Benefit Study;
- Provide informal feedback on these key elements, observed gaps and approaches to closing these gaps; and
- To consider whether the Smart Water Metering Cost Benefit Study in its entirety provides sufficient quantitative and qualitative insights to stimulate industry and government discussion on the role of smart metering in the Victorian Urban Water Sector.

The Draft Report was updated based on the feedback from the Peer Review Group and published to the DSE and stakeholders for consultation.

1.5.12 Forum 2 – Stakeholder Presentation

The intention of Forum 2 - Stakeholder Presentation was to present the key themes and findings contained in the Draft Report to all key stakeholders, in preparation for their review of the Draft Report.

1.5.13 Stakeholder Consultation

The stakeholder consultation period (approximately 4 weeks) provided key stakeholders with the opportunity to provide feedback and commentary on all elements of the Draft Report.

1.5.14 Final Report

At the end of the consultation period, all stakeholder feedback was collated and prioritised. Discussions were held with the DSE to determine the necessary changes to the Draft Report to reflect stakeholder feedback. Following this discussion, a draft Final Report was developed.

1.5.15 Peer Review of Final Report

The draft Final Report was provided to the Peer Review Group for review. Comments from the Peer Review Group have been addressed and have been incorporated into the Final Report (this report).

1.5.16 Forum 3 – Stakeholder Presentation

The intention of Forum 3 - Stakeholder Presentation is to present the key themes and findings contained in the Final Report to all key stakeholders. It is intended that this presentation will provide the impetus for industry discussion and debate on the relevance of smart water metering to the current and future Victorian Urban Water Sector.

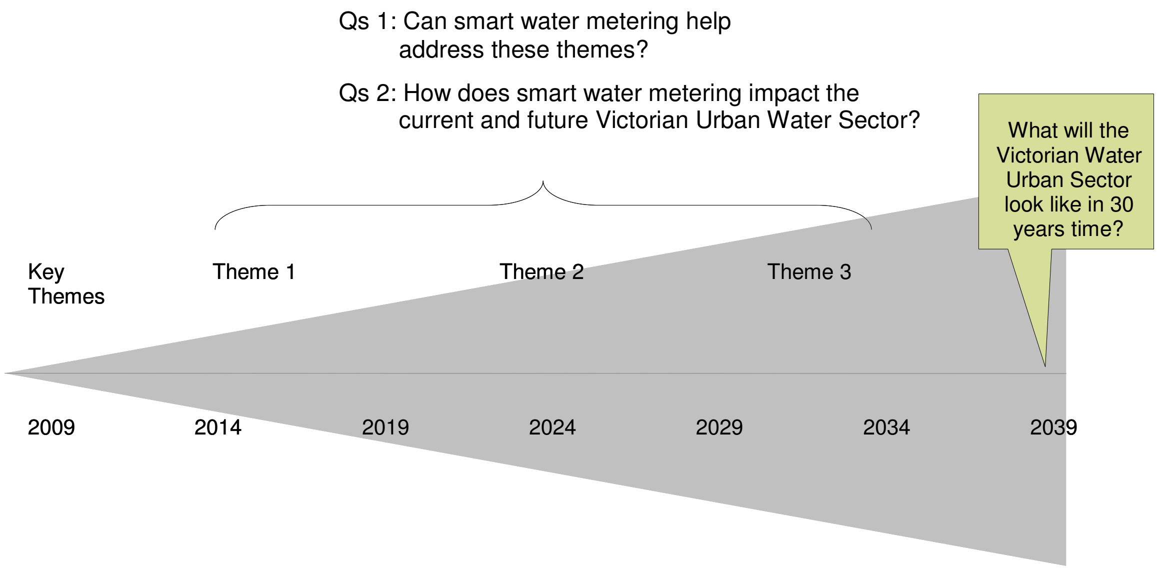
2 Context: The Victorian Urban Water Sector

2.1 Rationale

The purpose of this section is to describe the context of the Victorian Urban Water Sector over the next 30 years, in order to understand if and how smart water metering may be relevant to the sector.

It was considered possible to identify a number of key long term themes through discussion with industry participants. Once these themes were developed, certain assumptions relevant to the quantitative analysis could be determined and the context for the qualitative analysis could be established. Figure 2 (below) indicates how the themes may be conceptualised.

Figure 2: Rationale for the 30 Year Context



2.2 Overview

The Victorian Urban Water Sector is experiencing a prolonged period of changes in rainfall patterns and the amount of rainfall, resulting in diminished bulk water storage levels. These circumstances have placed scrutiny on bulk water planning processes and have necessitated the use of a severe and extended restriction regime to manage supply shortages, having an impact on customer amenity among urban water users.

In addition to these events, the following significant recent developments have been observed:

- The emergence of meaningful market-based rural water reform; and
- Industry stakeholders have started to challenge some long held views about the water sector, leading to development of urban – rural water trading and the application of new technology.

It seems undeniable that the Victorian Urban Water Sector faces a period of ongoing change. Technology intervention, in this case in the form of smart water metering, should be contemplated in the context of this changing future, rather than only implicitly or explicitly in the context of the current state.

To this end, this section outlines a consideration of characteristics which may become recognised as enablers of further ongoing improvement in the Victorian Urban Water Sector. The thoughts in this section are necessarily brief given the somewhat speculative nature of these considerations.

This section addresses three key areas:

- The likely long term themes for the Victorian Urban Water Sector;
- Given these themes, the potential institutional arrangements to emerge; and
- The relevance of smart water metering to these themes.

In the face of these changes, there will be more innovation across all aspects of the water supply value chain.

2.3 Likely Long Term Themes for the Victorian Urban Water Sector

After research and industry consultation, it is possible to identify a relatively small number of themes which seem likely to emerge in the sector. These themes are:

- The need to ensure security of supply;
- The requirement to ensure water is allocated and used efficiently; and
- Evolving regulatory and institutional arrangements.

2.3.1 Security of Supply

Security of supply has always been at the forefront of urban water sector planning. Decisions made in previous decades have generally delivered water security for urban water users. The prolonged period of reduced rainfall, along with increasing population has, however, brought a new focus on the need to secure supply.

This central theme may, more than any other, shape the water sector over the next 30 years, particularly given changing rainfall and hydrological patterns. A view that new 'natural' sources of water will not be plentiful and the need to guarantee security of supply are likely to drive:

- *An increasing dependence on 'high security' or 'manufactured' water:* The expected reduction in streamflows will result in a lower yield being available for our reservoirs leading those responsible for bulk water supply to seek alternative, more reliable sources of water supply;
- *A diversity of supply points, and sources of supply:* Probably including reservoirs, groundwater, recycled water, desalination, grey water re-use, storm-water, on site usage, etc. The use of these sources will reflect security, cost, price, responsiveness, underlying hydrology, regulation and potentially customer preference; and
- *An increase in efficiency as a result of securing supply:* It is expected that an increase in supply will result in the network operating at an optimal level thus driving efficiency.

2.3.2 Efficient Water Allocation and Usage

The efficient allocation of water and the efficient use of water are likely to become more prominent. This may result in:

- Scarcity becoming the key mechanism for promoting the efficient use and allocation of water, particularly if we continue to experience low inflows;
- More efficient water prices, which fully reflect externalities in the pricing of naturally occurring water sources and provide an appropriate return for high security water sources; and
- Customers who are better informed about their supply options, and who have choices in the manner in which they procure and consume water (e.g. quality, timeliness, etc).

2.3.3 Regulatory and Institutional Arrangements

The recently observed heightened customer, community and business interest in all matters relating to the water sector is expected to remain the case for the foreseeable future. This level of interest and scrutiny could be reflected in the regulatory and associated arrangements which will embrace the sector.

The water sector may become increasingly complex, with more entities active across the water supply value chain. This would in turn create the need for:

- More comprehensive, broadly based and pervasive regulatory regimes and practices;
- Greater transparency; and
- More certainty about water entitlements and property rights.

2.4 Potential Institutional Arrangements

Changes may be required to the current institutional and other arrangements to enable the nature of the themes outlined above to emerge. These changes are likely to be fundamental to the physical water supply chain and delivery network, pricing, retail functions, regulatory arrangements, and ownership and participation.

2.4.1 Physical Network

The first steps toward a more comprehensive supply grid are already emerging. This may become advanced, creating numerous links between:

- Demand and supply; and
- Manufactured water and storage.

It may be necessary to establish a Grid Manager, or a grid management function, to manage this complexity. An independent system operator, potentially acting as system planner and central procurement entity, may also be necessary.

2.4.2 Wholesale Markets

A market of some form – whether free and open, or centrally managed - for the wholesale supply of water may emerge, as it could be the most effective means to signal supply constraints and pricing options.

2.4.3 Retail Markets

The future for retail markets is less clear.

Water Authorities would be expected to keep their customers well informed of the price-service-security options locally available.

From a consumer's perspective, consumers may become more sophisticated and manage their own water arrangements:

- Large consumers may 'wheel' between different consumer sites; and
- Households may install their own water systems for non potable supply (e.g. irrigation purposes).

2.5 Relevance of Smart Metering to the Victorian Urban Water Sector

Even though it is difficult to accurately predict what the Victorian Urban Water Sector will look like in 30 years time, it is accepted that the sector will be more complex than it is today.

The relevance of smart metering to the Victorian Urban Water Sector can be summarised as follows:

- Metering that is able to deliver more comprehensive data more frequently than is available today, is likely to have a role in the future Victorian Urban Water Sector;
- The degree of sophistication of the water sector, hence the sophistication of the metering data to support this, is yet to be determined; and
- As water consumers become more sophisticated and interested in their water consumption, they are likely to demand more information and 'retail products' that better match their usage. Smart water metering may be relevant to supporting the needs of these consumers.

A number of key themes impacting the Victorian Urban Water Sector have been discussed in this section. It is possible that smart water metering has the potential to help address these key themes. However, given the uncertainty associated with the future, these will not be modelled in the quantitative analysis.

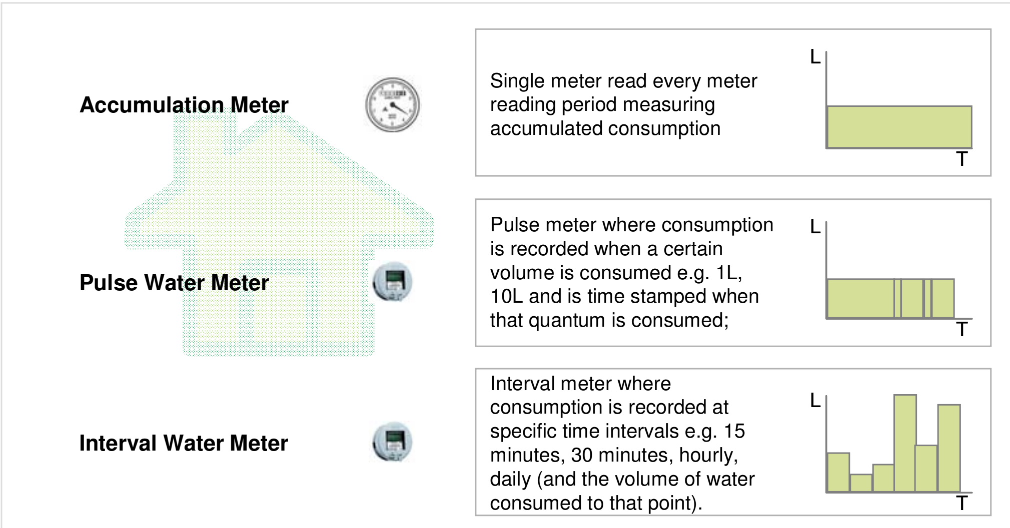
3 Smart Water Metering

3.1 Water Metering Definitions

3.1.1 Types of Water Meters

To date, water meters have been accumulation meters, pulse meters or interval meters. The differences in between these metering types are depicted in Figure 3 below.

Figure 3: Accumulation, Pulse and Interval Metering Data



The past decade has seen an evolution of conceptual design of advanced or smart metering and its terminology. Driven by electricity investment, metering has evolved from accumulation meters to interval meters with simple communications, to advanced or smart metering with an increased range of metering functionality. This increase in electricity meter functionality and complexity has started to be mirrored in the water industry.

Water meters installed in Victoria have traditionally been accumulation meters. Most water meters are read on a 3 monthly interval. Accumulation metering provides little information on consumer behaviour, other than total water consumption during the reading period.

In recent times, pulse capable water meters have been installed in Victoria, however, the meters are typically only used as accumulation meters despite their advanced capabilities. Pulse meters record a pulse when a quantum of water has passed through the meter. This quantum is configurable and can be set to values as low as one litre up to coarse pulses of many hundred litres. The number of pulses recorded by a meter and the time at which these pulses were recorded can be stored on the meter for subsequent collection (i.e. time stamped).

Interval metering measures the actual water used during a specific time interval. Time of use information provides a Water Authority with detailed information on when customers are using water, allowing detailed analysis of customer and network leakage and development of enhanced network models.

Interval metering is comparatively more expensive than pulse metering, as the interval meter is required to constantly monitor the water flows through the meter and record this volume at the expiration of the metering interval.

It is notable that by using a fine pulse quantum (say one to five litres) and analysing the time stamps of these pulses, pulse metering data can be used to approximate interval water metering data and hence deliver similar benefits.

Use of pulse metering (where a time stamp is made when a certain quantum of water is consumed) is more common in the water industry and these pulse meters are available at reasonable cost.

3.1.2 Smart Electricity Metering in Victoria

Under an Order in Council, the Victorian Electricity Distribution Businesses are required to install an Advanced Metering Infrastructure (AMI) communications network and Smart Electricity Meters for all small electricity customers (both residential and commercial) in Victoria. Rollout of electricity smart meters is to commence in 2009 and is due to be completed, including installation of communications networks, by 2013.

Electricity businesses provide Electricity Retailers access to their AMI communications networks. There may be opportunity for this infrastructure to be leveraged provided that commercial agreements between Water Authorities and Electricity Distribution Businesses that allow Water Authorities access so as to collect water meter data and send messages to their customers can be negotiated.

Furthermore, there may be opportunities for Water Authorities to leverage the Home Area Networks (HANs) that the smart electricity meters will enable. The HANs established by the smart electricity meters are based on ZigBee™[2] communications which potentially allow connection to other ZigBee™ enabled devices, which could include water meters.

3.1.3 Options for Smart Water Metering in Victoria

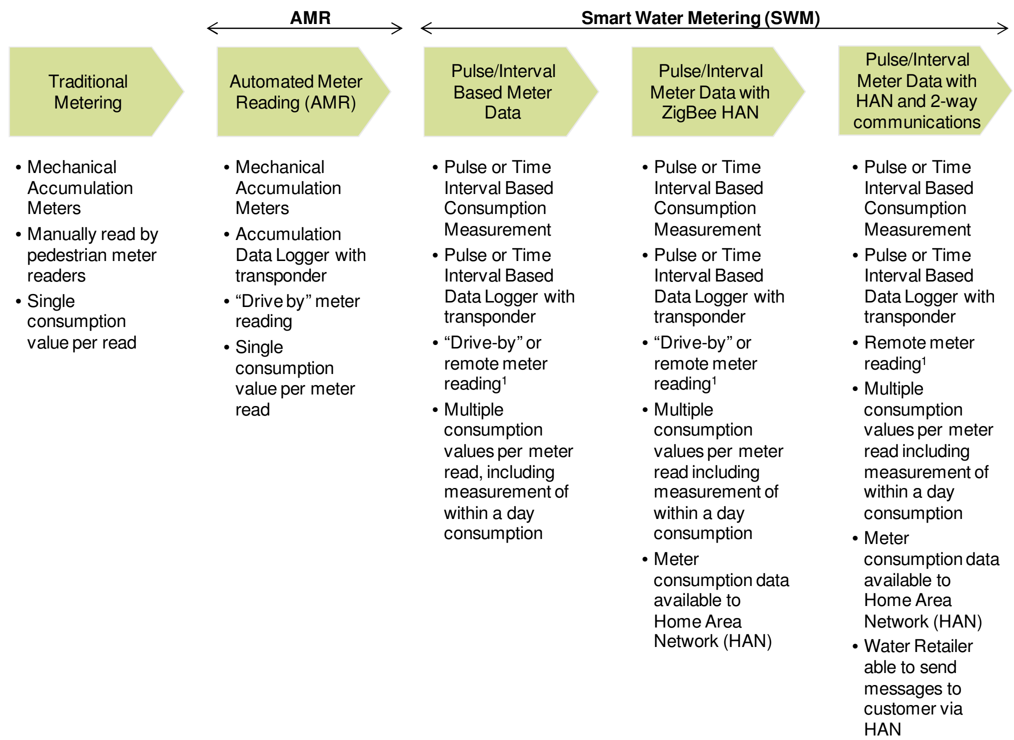
Smart water metering for the water industry will extend beyond the capability of 'Automated Meter Reading' (AMR). Smart water metering is expected to, as a minimum, establish more granular (within a day) water usage data, two-way communications between the water utility and the water meter, and potentially include communications to the customer (denoted 'Smart Water Metering'). With respect to a customer's household, smart water metering could enable:

- Recording of water consumption within a day;
- Remote meter reading on a scheduled and on-demand basis;
- Notification of abnormal usage to the customer and/or the water utility;
- Control of water consumption devices within a customer's premise;
- Messaging to the customer; and
- Customised targeting of segments.

[2] ZigBee™ is an open source protocol that allows low powered communications between compliant devices. To be compliant a device must be able to communicate in a specific ZigBee™ protocol. Protocols include basic metering functionality which may be able to be used by Water Authorities to collect water metering data.

The distinctions between various levels of metering are, in some cases, grey. However for the purposes of common terminology within this report the following metering definitions (Figure 4 below) have been developed.

Figure 4: Metering Definitions



[1] Remote meter reading is required for on-demand meter reading

The options to be considered for smart water metering are:

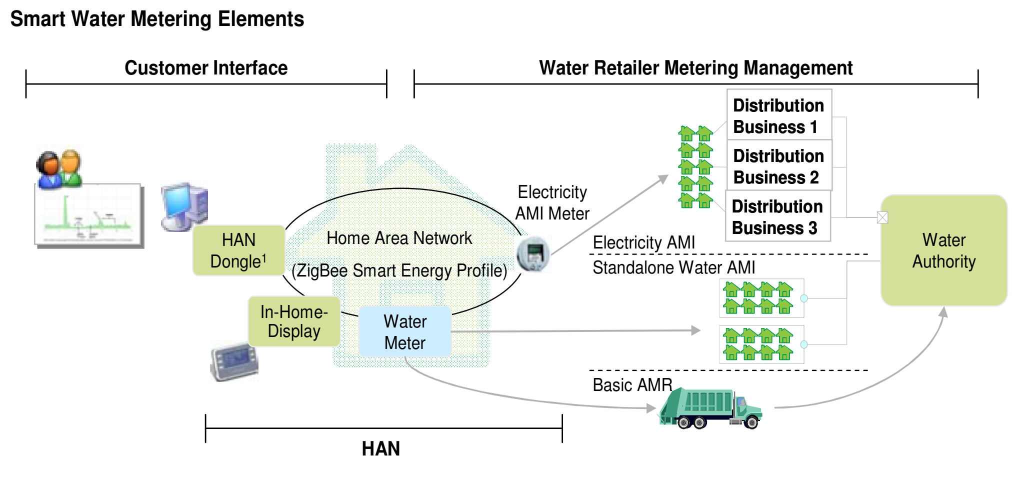
- *Choice of communication:* to the water authority and the home; and
- *Choice of consumption data measurement:* pulse metering or interval metering.

Options for the implementation of smart water metering communications arise through choices on:

- *Water Authority communications:* The method and frequency of data collection through either drive-by collection, leveraging electricity AMI communication networks or standalone water AMI communications networks; and
- *Customer communications:* The method of communicating consumption information to customers: either in real-time across a Home-Area-Network (HAN), or in a historical manner through bills.

The key elements considered (or excluded) within each implementation option evaluated by the Study are illustrated in Figure 5 overleaf. This diagram depicts the high level relationships between customers, the household (or metered site), and the Water Authority.

Figure 5: Smart Water Metering Logical Architecture



[1]A dongle is a small portable piece of hardware that connects to a computer or laptop.

The final driver of 'implementation optionality' is the consumption data measurement and recording method.

A smart water meter could record consumption data in two ways, either:

- *Pulse:* Where a metered consumption data point is recorded when a certain volume is consumed (e.g. 1L, 10L, 100L and at what time and date); or
- *Interval:* Where a metered consumption data point is recorded at specific time intervals (e.g. every 15 minutes, 30 minutes, hourly, daily and the volume of water consumed to that point).

The electricity industry has decided on measurement of consumption using interval metering. This decision is based both on historical practice for remote metering of electricity consumption as well as alignment to the measurement standards of the National Electricity Market, which is ½ hour based. Interval metering is crucial to the National Electricity Market for the following reasons:

- Electricity wholesale market trading is conducted on a ½ hourly settlement basis, therefore, measurement of customer energy consumption on a ½ hourly basis will facilitate wholesale market trading activities; and
- Electricity generation, transmission and distribution infrastructure can be constrained, particularly during periods of extreme heat and high air-conditioning load - ½ hour consumption data allows the grid manager to balance electricity supply and demand during these critical peak periods.

The above practices and drivers of interval metering are not universally established within the water industry:

- Water can be stored;
- Given recent changes in customer behaviour and decreases in water consumption resulting from prolonged water restrictions, periods of peak demand are less of a problem in the water industry; and

- The current peak consumption is significantly less than infrastructure capacity, and pressure and flow management within the constraints of the respective customer charter can be readily used as an effective tool in periods of high demand.

However, it is recognised that peak demand could be a potential problem in the water sector downstream of service reservoirs. If all customers are watering the garden simultaneously, there would be a significant pressure drop.

Minimum pressure requirements, as defined in each Water Authority Customer Charter, encourage redundancy in design capacity to meet potential needs which results in poor asset utilisation and over capitalisation. There are others ways to deal with such issues if means are in place to differentiate time, rate and price paid for water use.

Further, time of use is a key parameter used in applying water restrictions. Ability to monitor such direction is currently limited since there is no knowledge of a consumer's use on a real time basis.

3.2 Smart Water Metering Implementation Options

Six alternative smart water metering Implementation Options were considered for the quantitative and qualitative analysis. These approaches are:

- *Implementation Option 1*: Weekly AMR Services;
- *Implementation Option 2:* Weekly Pulse Meter Data Collection;
- *Implementation Option 3:* Weekly Pulse Meter Data Collection plus In House Display;
- *Implementation Option 4:* Daily Pulse Meter Data Collection using Electricity AMI plus In House Communications;
- *Implementation Option 5:* Daily Interval Meter Data Collection using Electricity AMI including In House Communications; and
- *Implementation Option 6:* Daily Interval Meter Data Collection using Water AMI including In House Communications.

Further details of the smart water metering Implementation Options are contained in Figure 6 overleaf.

Figure 6: Smart Water Metering Implementation Options

AMR	1	**Weekly AMR Services**	Weekly Accumulation Metering Data Collection using drive-by technology
Smart Water Metering	2	**Weekly Pulse Meter Data Collection**	Weekly Pulse Meter Data collection using drive-by technology
	3	**Weekly Pulse Meter Data Collection plus In House Display**	Weekly Pulse Meter Data collection using drive-by technology plus a ZigBee communications module enabling display of meter data on an in house display
	4	**Daily Pulse Meter Data Collection using Electricity AMI plus In House Communications**	Daily Pulse Meter Data collection using ZigBee communications to the Electricity AMI Communications Network including in house communications
	5	**Daily Interval Meter Data Collection using Electricity AMI including In House Communications**	Daily Interval Metering collection using ZigBee communications to the Electricity AMI Communications Network including in house communications
	6	**Daily Interval Meter Data Collection using Water AMI including In House Communications**	Daily Interval Metering collection using a standalone AMI Communications Network built by individual Water Corporations including in house communications

A full description of each of the implementation options follows.

3.2.1 Implementation Option 1: Weekly AMR Services

This approach uses drive by data collection technology, and accumulation meter reads from automated meter reading enabled meters, where data is collected on a weekly basis. Meter reads are collected using RF or similar technology. A data collection device is attached to a vehicle which drives past each AMR capable meter to collect the data. This is commonly called a 'garbage truck scenario' as these vehicles travel the routes most likely to be required for meter reading on a regular weekly schedule.

Only accumulation meter reads are collected (i.e. similar meter data to what is currently collected today). This reduces the costs associated with storage of meter reads on the meter and meter data management once the data is collected.

3.2.2 Implementation Option 2: Weekly Pulse Meter Data Collection

This approach uses drive by data collection technology, and pulse meter reads from automated meter reading enabled meters, where data is collected on a weekly basis. Meter reads are collected using RF or similar technology. Pulse metering allows the Water Authority to identify water consumption patterns. Pulses are configurable in discrete quantities (typically, 1L, 10L, 100L, etc) and a single pulse is generated when the quantity of water is consumed. A data logger connected to the meter records the date and time of each pulse generated by the meter (i.e. each pulse is time stamped).

As with Implementation Option 1, a data collection device is attached to a vehicle (e.g. a garbage truck) which drives past each AMR capable meter to collect the data. Collection of weekly pulse meter reads can approximate time of use metering through mapping the timestamp of each pulse collected into discrete time intervals.

3.2.3 Implementation Option 3: Weekly Pulse Meter Data Collection plus In House Display

This approach uses the same metrology and collection mechanism as Implementation Option 2, but includes a ZigBee™ communications module (or similar) in each meter to allow connection and delivery of meter data to an in house communications device. The capabilities provided to Water Authorities are the same as Implementation Option 2.

In addition to the Water Authority capabilities, the customer will be able to display, via the ZigBee™ communications module, invalidated[3] metering data directly from their meter and use this data to make informed choices concerning their water usage.

While noting that using two radios in each meter is undesirable and may have deleterious effects on battery life, ZigBee™ radios may not be able to be used for drive-by metering data collection, hence the second radio is required. The ZigBee™ protocol relies on secure binding between individual devices on a Home Area Network to transmit metering data.

In practice, this means that a collector (on the mobile collection vehicle) would need to bind with each water meter on the collection route. This imposes operational limitations on collection of metering data as specific vehicles will need to be allocated to each metering route.

3.2.4 Implementation Option 4: Daily Pulse Meter Data Collection using Electricity AMI plus In House Communications

This approach uses the same metrology as Implementation Option 2, however, data is collected by accessing the Victorian Electricity AMI networks (operated by Electricity Distribution Businesses).

Using ZigBee™ communication and the Electricity Distribution Businesses AMI communications network, collection of pulse meter data can occur as often as every day.

Under this Implementation Option:

- The Water Authority could send communications to customers (i.e. for improved management of network outage periods, water usage analytics and alerts, customer education, etc); and
- Customers can display invalidated metering data from their water meter via the electricity AMI meter to make informed choices concerning their water usage.

3.2.5 Implementation Option 5: Daily Interval Meter Data Collection using Electricity AMI including In House Communications

This approach uses the Electricity AMI communications network (including ZigBee™ enabled electricity meters) to communicate to an interval data enabled water meter. The water meter measures the water consumption in a specified (and configurable) period. Using ZigBee™ communication and the Electricity

[3] Invalidated metering data is raw metering data that has not been checked for incorrect reads such as high/low reads, missing reads and corrupted data. Metering data is validated before bills are prepared.

Distribution Businesses AMI communications network, collection of interval meter data can occur as often as every day.

Naturally, there will be increased meter data management requirements for collection of daily metering data and collection of internal metering data when compared to collecting a smaller number of data points on a weekly basis.

Under this Implementation Option:

- The Water Authority could send communications to customers, and
- Customers can display invalidated metering data to make usage decisions.

3.2.6 Implementation Option 6: Daily Interval Meter Data Collection using Water AMI including In House Communications

This approach uses a standalone water AMI network to provide daily interval water metering data to the Water Authority. The water AMI network could be built by each individual Water Authority and operate independently of all other Water Authority AMI networks (e.g. via their own SCADA networks for backhaul communications), or a shared approach to construction and operation of a water AMI network involving all Water Authorities could be considered. The cost of construction and operation does not significantly differ between these Implementation Options.

The water AMI communications network will consist of a considerable number of district concentrators, which collect data from water meters, and backhaul communications mediums to transfer the metering data to the Water Authority. Construction and operation of such a network can be costly.

Meter data collection is dependent on the construction approach of the water AMI network. Individual AMI networks would lend themselves to independent meter data management functions. A shared AMI network could lead to the creation of a shared water meter data management function (refer Section 3.3.2).

The cost benefit analysis adopted in this Study considers the individual Water Authority approach to AMI network construction and meter data management.

Under this Implementation Option:

- The Water Authority could send communications to customers; and
- Customers can display invalidated metering data to make usage decisions.

3.3 Victorian Urban Water Sector Reform Options Not Considered

3.3.1 VCEC Market Reform Options

The Literature Review (refer **Appendix A**) highlighted that the following industry reform options were recently considered by the Victorian Government (namely the Victorian Competition and Efficiency Commission - VCEC), but their applicability to a future Victorian Urban Water Sector has not yet been determined:

- Competitive sourcing of water supplies;
- Competition in the market for retail services;
- Third party access;
- Regional water trading;
- Retail deregulation, full retail competition;
- Delivery entitlements market;
- Water grid manager; and
- Tariff reform.

Given the need to analyse and evaluate the impact with the adoption of these reform options, the impact of these options on the selected Implementation Options was not considered in the quantitative analysis, however, some elements of these options are considered in the qualitative analysis.

3.3.2 Shared Services Options

One approach to reducing the cost of the IT investment for all Implementation Options would be to implement a shared services arrangement (was recently considered as a possible VCEC reform option for industry cost savings) for meter data collection and validation, and depending on business rules adopted, potentially meter data substitution and estimation.

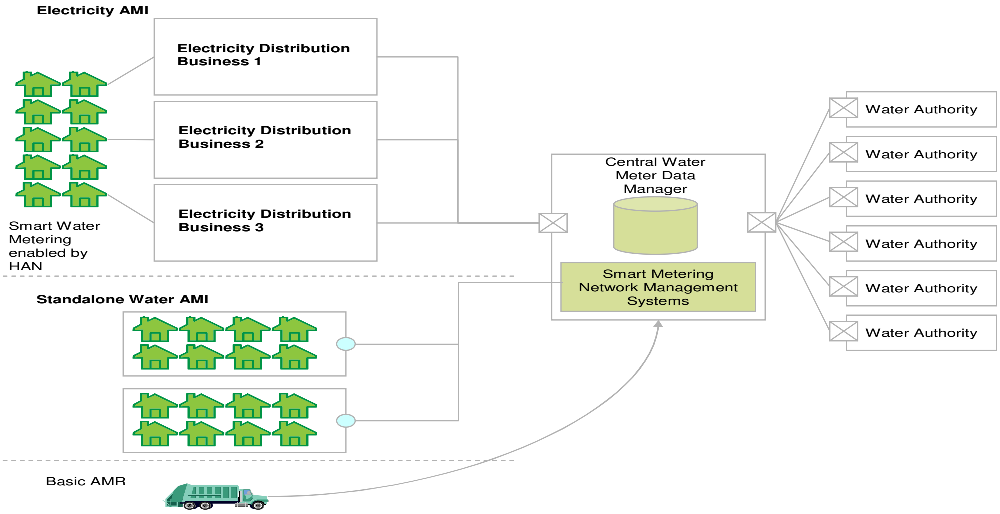
Such an approach, while requiring higher single investment in establishment of the Central Meter Data Manager, is likely to result in lower individual IT investment for each Water Authority. Inbound meter data management could occur in a consistent manner for all Water Authorities as ‘customers’ of the Central Meter Data Manager, and meter data aggregation could be undertaken to satisfy Water Authority billing requirements (refer Figure 7 overleaf).

The electricity industry has considered the potential cost savings through implementation of a centralised model for meter data management, but has not adopted the approach.

This is possibly due to the disaggregation of distributor and retailer functions in the electricity network, which lead to differing interests with respect to meter data management (and control), with the outcome being that there is no common industry objective to implementing such an approach. The mixture of public and private ownership of these businesses and the fundamental reliance on meters and the 'cash register' of the businesses also impacts the joint sourcing of this service.

The water industry, given its current vertically integrated distributor and retailer functionality, could more easily agree to implement such a model. While the approach would reduce the cost of IT investment associated with meter data management, insufficient clarity existed with respect to a shared services approach to warrant inclusion in the cost benefit analysis.

Figure 7: Shared Services Approach to Meter Data Management



4 Quantitative Analysis

This section documents the findings regarding the tangible, or quantifiable, benefits and costs of smart water metering. These benefits and costs are predominantly from the perspective of the Water Authority. The key elements of this section are as follows:

- Benefit and cost elements driving the quantitative analysis;
- Key assumptions of the quantitative analysis, both at a universal level and for specific Implementation Options;
- The Net Benefits and Net Present Value (NPV) for each Implementation Option; and
- Sensitivity analysis with respect to meter procurement, scheduled and special meter reads, IT systems, water pricing, network and household leakage, the cost of ZigBee™ communication modules and capital efficiency.

Policy development and qualitative customer impacts have not been included as there is limited sound information available to appropriately quantify these elements. Qualitative analysis, including these elements, is discussed in Section 5.

Please note that Section 6 contains an overall assessment of the quantitative and qualitative analysis.

4.1 Benefit and Cost Elements

The Literature Review (refer **Appendix A**) highlighted many possible benefits and costs associated with the implementation of smart water metering. The benefits and costs typically comprised reduced water leakage, improved asset management, reduced cost of retail operations, customer benefits, and smart meter and associated systems costs. Based on the findings of the Literature Review (refer **Appendix A**) and the outcomes of the interviews with the Water Authorities, development of the cost benefit analysis for this Study gave rise to consideration of the following key benefit and cost elements:

- Meter procurement, installation and maintenance;
- IT systems;
- Meter reading and communications;
- Customer service; and
- Asset management.

The approach in this Study was to assess the change in the benefit and cost elements, when compared to a 'Status Quo' scenario.

The benefit and cost elements considered are listed below.

4.1.1 Meter Procurement, Installation and Maintenance

This element contains the following costs:

- *Cost:* Procurement of accumulation, pulse and interval meters with increasing capability for each Implementation Option; and
- *Cost:* Communications to the household (via ZigBee™ or similar technology).

4.1.2 IT Systems

This element contains the following costs:

- *Cost:* Provision of metering data to the Water Authority and the associated meter data management costs;
- *Cost:* The upfront costs of integration of IT systems with new meter data;
- *Cost:* Electricity AMI access and usage charges, the cost of electricity DB interfaces;
- *Cost:* Capital and operating costs for a standalone water AMI, the cost of a communications network management system; and
- *Cost:* Process redesign and staff training.

4.1.3 Meter Reading and Communications

This element contains the following benefits and costs:

- *Benefit:* Manual meter reads and special meter reads;
- *Benefit:* Increased efficiency of water consumption (by 'involved' consumers);
- *Cost:* Remote communications to the Water Authority (via 'drive-by' or AMI technologies);
- *Cost:* Communications associated with automated meter reading;
- *Cost:* Electricity AMI access and usage charges, the cost of electricity DB interfaces; and
- *Cost:* Capital and operating costs for a standalone water AMI, the cost of a communications network management system.

4.1.4 Customer Service

This element contains the following benefits and costs:

- *Benefit:* High bill enquiries;
- *Benefit:* Credit, collection and remittance processing;
- *Benefit:* Back office; and
- *Cost:* Front office and call centre activities.

4.1.5 Asset Management

This element contains the following benefits:

- *Benefit:* Customer leaks management;
- *Benefit:* Network leaks management;
- *Benefit:* Capital efficiency for growth infrastructure;
- *Benefit:* Capital efficiency in replacement expenditure; and
- *Benefit:* Pressure management.

4.2 Key Assumptions

A number of key themes and potential institutional arrangements impacting the Victorian Urban Water Sector have been discussed in Section 2.5. It is possible that smart water metering has the potential to help address these key themes and institutional arrangements, however these are difficult to model in the quantitative analysis.

The key assumptions can be summarised as follows:

- *Universal:* Apply to all of the Implementation Options evaluated; and
- *Specific:* Apply to a specific Implementation Option (i.e. Implementation Options 1 – 6).

4.2.1 Universal Assumptions

Representative Water Authority benefits and costs are used:

- Benefits and costs are not directly attributable to any specific Water Authority;
- Benefits and costs may be overstated or understated for individual Water Authorities;
- Benefit and cost differences between 'large' Water Authorities and 'small' Water Authorities have been considered in the cost benefit analysis;
- All Victorian Water Authorities have been included in the cost benefit analysis; and
- Only residential customers have been included in the cost benefit analysis.

Price of water:

- The retail price of water is assumed to be based on current 'Block 1' residential water usage charges as prescribed by the Victorian Water Authorities (i.e. applies to the lowest consumption and cheapest tariff block);
- For residential customers, the bulk water price (i.e. sale of water from wholesaler to retailer) and the retail price (i.e. sale of water from retailer to customer) have been considered.

There are minimal changes to tariff structures and billing frequency:

- While weekly and daily pulse or interval data provides for innovative tariffs, better block tariff arrangements and changes to billing frequency, these arrangements have not been included in the quantitative cost benefit analysis.

Customer behaviour:

- The current water conservation culture established by the use of prolonged restrictions will be maintained; and

Meters are replaced on a 10-year cycle:

- A 10-year meter replacement cycle was the median and the mean meter replacement cycle of the interviewed Water Authorities – this has been assumed as the standard meter replacement cycle in the analysis; and
- Limited additional installation costs are incurred when using a 10-year replacement cycle.

Life of technology is assumed to be 10 years:

- Technology investment in meters, communications and IT systems are assumed to have a 10 year investment life cycle;
- Increased annual IT maintenance costs, as a result of smart water metering, are included; and
- Subsequent investment in replacement of upgraded IT systems is assumed to be a 'business as usual' activity and is not included in the analysis (for example, replacement of retail billing systems occurs on a periodic basis, regardless of adoption of smart water metering).

Special meter reads:

- Special meter reads will no longer be required under both weekly read and daily read scenarios; and
- Weekly reads are assumed to be sufficient for calculating customer's final bills.

Customer service will remain largely unchanged:

- Providing additional information to customers will result in positive customer behaviours such as self management of water usage and reduced bill shock, but will also result in additional queries as the information is made available;
- Changes to billing information associated with the introduction of smart water metering is likely to result in a net increase in customer contact during the initial roll out period; and
- Net benefits are assumed to be small over a 30 year period.

Cost of communications:

- The costs of communications have been based, in part, on the costs identified in the Victorian Electricity AMI project.

In house communications penetration:

- Adoption of in house communications to view consumption information will be opt-in and will not be adopted by all customers in Victoria with only 50% of customers assumed to adopt this technology; and

- Only a fraction of these customers (modelled as roughly a quarter of the 50% of customers adopting the technology) will actively monitor their own water consumption via in house communications technology over time.

Network operating pressure remains constant:

- The increase in water delivered to customers will not significantly affect the operating pressure of the network; and
- The network leakage rate is unchanged; therefore leaks will only increase with increased water delivery.

Asset management benefits can be captured through periodic meter data delivery:

- The improvement in customer leakage management is based on quicker identification of leaks on the customer's premises through more frequent meter reading;
- Asset management benefits are achieved through improved network flow modelling and work management - it is assumed that these benefits, while relying on interval data for improved analytics, can be captured through pulse metering and periodic delivery (say weekly) of data; and
- Asset Management benefits result in improved capital efficiency for 'growth' expenditure only (we have not considered 'replacement' expenditure).

4.3 Summary of Quantitative Analysis

The key findings of the quantitative analysis are as follows:

- Financially positive outcomes can be demonstrated for Implementation Options 1 – 4, which involve either more frequent collection of either simple accumulation metering data from current meters, or more frequent collection of pulse metering data;
- Collection of interval metering data via Implementation Options 5 and 6 provides a financially negative outcome – the meters and associated systems are more expensive and the information is no more valuable than the pulse information;
- A significant variation in the cost of a ZigBee™ communications module did not significantly impact the base case results for Implementation Options 3 and 4; and
- Variations in the price of water, reductions in network and household leakage rates and improvement in capital efficiency can drive, in extreme cases, NPV negative results for Implementation Options 2 – 4. However, Implementation Options 5 and 6 remain financially negative with variation in all of the aforementioned input variables.

Overall Implementation Options 1 - 4 appear to provide the most viable cases for further consideration by the Victorian Urban Water Sector.

5 Qualitative Analysis

This section of the Report documents the findings regarding benefits of smart water metering that were not easily quantified. These qualitative impacts are divided into four areas:

- Customer impacts;
- Societal impacts;
- Policy impacts; and
- Environmental impacts.

Where sufficient information has been provided to enable quantitative analysis of these impacts, that quantitative analysis has been included in the previous section of this report. There are also further areas of impact, where little quantitative information is available, and therefore reliance is placed instead on qualitative description of the impacts in this report section, rather than on quantification.

The quantitative analysis in the previous report section was bound by the assumptions that were documented there. In this report section, we are able to consider possible impacts in a future environment that may differ more substantially from the current status quo.

5.1 Customer Impacts

The customer impacts that are considered here relate to:

- Customer empowerment;
- Household leaks;
- Changes in billing;
- Smart water appliances; and
- Customer relationship management.

The following sub-sections explore each of these areas of customer impact in more detail.

5.1.1 Customer Empowerment

A key message from most, if not all of the interviews with the Water Authorities on qualitative impacts of smart water metering, was that customers are highly aware of the need to use less water, and have a strong desire for more information about their water use.

Water Authorities reported that customers react better to being given information about the volume of water that they use and how that compares to average usage or to targets set by governments or by Water Authorities, than to information on the cost of water. Several Water Authorities stated that water conservation campaigns focused on the cost savings that could be achieved through reduction in water consumption were ineffective in persuading customers to reduce usage. In contrast, campaigns that were focused on managing consumption volumes by comparison to mandated targets or other volume benchmarks have proven to be effective in encouraging customers to reduce their water usage.

The primary contributing factor for this is the low cost of water: saving 10 litres per day every day for 3 months would only save around $1, while saving 10 litres per day against a target of 155 litres is quite a significant achievement.

This finding was also supported by information discovered through the Literature Review (refer **Appendix A**) which indicated that on average water is less that 1% of household expenditure, hence price based mechanisms are unlikely to achieve changes in customer consumption behaviour. Whilst information on demand elasticity is scarce, the information that is available supported this.

Water Authorities also reported that customers do have a desire to meet mandated targets. However, because they do not read their meters on a frequent basis, and only receive bills on a quarterly basis, they do not have sufficient timely information to understand their water consumption. Therefore, customers are unable to measure their performance against the targets, and the value of these campaigns is impaired. For example, the Target 155 campaign encourages customers to consume no more than 155 litres of water per person per day. This campaign could be even more effective if consumers had more frequent access to consumption data, thus allowing them to compare their water usage with the target much earlier, as compared to the current cycle of quarterly billing.

Currently, at the end of the billing cycle, the only information that the consumer gets is how their average daily consumption over the previous quarter compared to any given target. Further, and frustratingly for the consumer, there is no additional information available that informs the consumer how to change their behaviour to meet the target in future.

Smart water metering could provide more frequent (perhaps daily) data, which would assist customers in monitoring their usage. With daily meter data, the consumer could be informed about their daily consumption on each day of the billing period, and how each day’s consumption measured against the target. This would give more focus to enable the consumer to evaluate their water consumption to assist them in addressing the behaviour that has caused them to have consumption that exceeds the target.

If (near) real time data, or more granular data, could be made available to customers from smart water metering, this could enable customers to gain much more information on their water usage at different times of day, and hence to get a better understanding of their water usage profile and how it measures against other consumers’ profiles. This could give consumers better insights into their periods of high and low usage, which would enable them to conduct more timely and more effective investigation of high usage levels.

Based on their knowledge of what use was being made of water at those times, they would also gain an understanding of where in the household and for what purposes the various metered quantities of water were being used at different times. Customers could use the information gained from smart metering to change their behaviour, and in some cases to justify an investment in new appliances that could be more water-efficient than their existing appliances.

As water becomes more valuable to consumers, smart metering with information provided to the consumer via a HAN would also enable a consumer to trade water with their neighbours, allowing water to be metered though their meter but used by a customer at a different location. The customer allowing their neighbour to use the water may then charge their neighbour for the water use.

Additionally, smart water metering would provide a level of information to Water Authorities which reveals the extent to which customers are pursuing alternative water supplies e.g. grey water systems and water tanks. Currently, Water Authorities do not have readily access to this information.

The Literature Review (refer **Appendix A**) also indicated that customers prefer to make their own consumption decisions, rather than having restrictions dictated to them. The Australian Bureau of Agricultural and Resource Economics (ABARE) and the National Water Commission agree that water restrictions are inequitable and a relatively inefficient mechanism. To the extent that smart water metering could be used to obviate the need for restrictions, this would give a qualitative customer benefit.

5.1.2 Household Leaks

Discussions with Water Authorities indicated that household leaks are a serious problem for some customers, at times leading to bills higher than they can afford to pay. Besides the value of the loss of water (which has been assessed in the quantitative analysis), unchecked and prolonged leaks can cause serious damage to a customer's property.

We have also been informed that after years of improving network leakage management, the industry suspects that addressing leakage on customers' premises may provide sufficient reductions in water usage to postpone significantly the next supply augmentation.

Water leakage is difficult to detect from quarterly consumption data, especially in the case of those that develop over time and therefore come to be seen to be part of the customer's normal usage profile. Visibility of water consumption across the day, and particularly at night, or at other times when usage should have been zero, can help to detect leaks and bursts much more quickly, thus mitigating their impact on customers. Smart water metering could provide visibility of such information to consumers.

It must be acknowledged that identification of the existence of a leak does not necessarily lead to the leak being fixed. Smart water metering may provide incentives for customers to rectify identified leaks through innovative tariff structures.

5.1.3 Changes in Billing

Discussions with Water Authorities identified the following potential smart water metering enabled changes to water billing:

- Innovative retail tariffs for the sale of water;
- More frequent billing;
- More accurate billing; and
- Advantages to customers of meter readers not having to come on to their property to read meters.

Innovative retail water tariffs:

Innovation in commodity retail tariffs is generally driven by one of two factors. In integrated markets, tariff innovation is driven by a need to achieve a policy outcome. In disaggregated competitive markets, tariff innovation is driven by the need to manage commercial risk.

While the Victorian Urban Water Sector has been corporatised, the sector remains an integrated market from the perspective that the Water Authorities receive an entitlement to the water that they distribute and sell to their customers.

As discussed, there is no wholesale market for water, and the transmission and distribution systems have capacity to meet the current and foreseeable demands for water movement in Victoria.

During the interviews with Water Authorities and other industry stakeholders, Time of Use (TOU) and Critical Peak Pricing (CPP) water retail tariffs were discussed, but the consensus view was that these types of tariff are not currently necessary, and would not be necessary for some time, if at all.

Based on the recent Essential Services Commission (ESC) the retail cost of water in Victoria may be rising for the next four years, and that this cost increase is reflective of the introduction of manufactured water into the bulk water supply mix. As noted above, water is only a small proportion of household expenditure, and price is unlikely to be a significant driver of water consumption for many consumers.

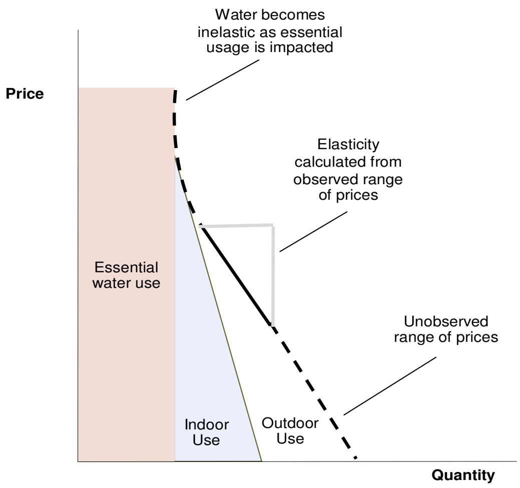
The Literature Review (refer **Appendix A**) revealed, in relation to demand elasticity, that it could be concluded that even if there were a doubling of the retail price of water, the cost of water may not become a material driver of consumption for many consumers.

The studies that have been undertaken further lead us to consider that elasticity could differ between water that is used for essential purpose (i.e. for indoor use) and non-essential purposes (i.e. for outdoor use). Some studies have found outdoor use to be relatively elastic. It seems that major price-related savings may occur outdoors, since the majority of people regard home water use as important to their lifestyle (85%), and home gardening is still the most popular recreational activity in Australia. The advantage of such a behavioural approach is that the impacts of pricing on day-to-day activities can be measured, as well as price elasticity, which can help in water planning and in the design of pricing policies. Smart meters would provide a valuable data platform for such analyses to be conducted.

Water elasticity has historically been examined within a range of 'typical' prices, of the same order of magnitude as Australia's current pricing of $1-2 per kL. It is not clear how elasticity, or the effect of price on demand, might change as the price becomes drastically higher (or lower).

Figure 8 below illustrates how elasticity's observed value (the gradient of the curve) may conceal different price responses for different water uses, and for unfamiliar price levels.

Figure 8: Characteristics of Water Demand Elasticity



The benefits of innovative tariffs could be tested through further research and trials that smart water metering could facilitate. Such trials could be combined with record-keeping by consumers regarding the uses for which they consume water at the various times of day. Analysis of the diary records combined with the granular meter data could provide fresh insight into variations in elasticity of demand between essential and non-essential uses, and could help to establish the parameters of what is essential water use.

Even with smart water metering, it would not be expected that the metering would be sophisticated enough to detect the difference between essential and non-essential use, other than in the applications of research and trials, as discussed above. It would therefore not be expected that indoor use would be differentiated from outdoor use. As a further example, even within a single room in the household, a shower may be considered essential use but a spa bath may be considered non-essential. Smart water metering would not measure these uses separately, and therefore they would not be charged on different tariffs. Differential tariffs could, however, apply where there is a separate pipe carrying the water to the household, and thus the supply is separately metered. Thus, non-potable recycled water would be metered separately, and hence different tariffs could apply.

It is recognised that the ability to differentiate between potable water uses in the household may not be necessary. Innovative block tariffs could provide households an annual allocation of essential water at a specific volume and at a specified price. If households use more water, regardless of the type of usage, they would pay more.

Despite the uncertainties around water retail tariffs, it is widely expected that:

- Consumer tariffs will rise significantly over the next five years;
- Inclining block tariffs may be reviewed; and

- Complex time-of-use water retail pricing is unlikely to develop in the foreseeable future, if at all.

Accordingly, innovation in water retail tariffs is currently not a driver for smart water metering. However, in the future, smart water metering could provide infrastructure to support the establishment of a wide variety of innovative tariff structures, in diverse price-service-security value propositions, and potentially embracing options for customer choice that are not currently available.

More frequent billing:

As discussed above, customers do not generally read their own meters. Instead, they rely on their bill for consumption information. Quarterly billing does not provide sufficiently granular information for customers to effectively manage their water consumption. One way to provide more granular information would be through more frequent billing. This could be facilitated through more frequent meter reading using AMR or Smart Water Metering. However, as discussed above, it is water usage rather than cost information that drives customer behaviour, and smart water metering can deliver water usage information to customers through means other than billing.

A case for more frequent billing cannot be made simply on the basis of a qualitative benefit of driving customer behavioural change. A more detailed analysis that compares the benefits to the Water Authority of increased cashflow and possibly lower bad debts to the increased costs of bill production, mailing, call centre and payment processing would need to be conducted.

More accurate billing:

A small reduction in call centre costs was identified and included in the quantitative analysis as being associated with more accurate billing. There is also a qualitative benefit for some customers. A small proportion of water bills are currently based on inaccurate usage data, due either to a missed read (through an inaccessible meter, or locked gates and owner not present, or a dog protecting the property), or a misread – where the meter reader does not read the meter accurately. Smart water metering could prevent these problems.

Interviews with Water Authorities indicated that access to the vast majority of water meters is not an issue, and human meter reader error rates are small. Thus, a significant qualitative benefit of more accurate billing would only accrue to a small number of customers.

Meter readers entering customers' properties to read meters:

Unlike electricity meters, which are typically mounted on an external wall of the dwelling on a property, most water meters are located on the property boundary, generally at the front of the premises.

In many cases, water meter readers therefore do not have to come onto a customer's property to read the meters. No significant qualitative benefit can be attributed to the avoidance of meter readers entering customer properties to read meters.

However, it is recognised that this is a function of meter positioning which has been established for the convenience of the meter reader. Future value may be better served if a broader set of requirements were taken into consideration, including, for example, power availability at the meter site through clustering utility meters. This would greatly assist remote operation and monitoring, which could be an important benefit for the future.

5.1.4 Smart Water Appliances

In the electricity industry, 'smart appliances' are appliances that can be remotely controlled by the consumer or an electricity business via the AMI Communications Network and the ZigBee™ Home Area Network. It is anticipated that new appliances will become available that will be programmed to respond automatically to different pricing at different times of day. For example, a smart refrigerator may delay its defrost cycle until an off-peak period when electricity is cheaper, or a smart air conditioning system might be cycled by the local electricity distributor during periods of peak demand to reduce strain on the network. Signals to these appliances will be communicated through a smart electricity meter.

In contrast, smart water appliances, such as low-fill washing machines, are smart in their intrinsic operation, rather than through scheduling their hours of operation. They do not rely on a remote or automatic signal through a smart water meter in order to optimise their operation. Optimisation of the energy usage of a washing machine or dishwasher can be provided by a smart electricity meter.

In summary:

- Smart water appliances will impact on water usage, whether or not the appliance is connected to a smart water meter or a smart electricity meter;
- Smart electricity metering will impact on the energy usage of smart appliances, including smart water appliances; but
- There is currently no clear direct linkage between smart water metering and the water or energy use of a smart water appliance, though that is not to say that no linkage might be found in the future.

5.1.5 Customer Relationship Management

Water Authorities have very little systematic longitudinal knowledge about their residential customers despite the occasional cross sectional market surveys, small scale domestic water use studies and trials with varying levels of service such as water pressure.

During the interviews, Water Authorities noted that customer information from smart water metering could enable them to target their communications more accurately to the specific customer types. Examples from the interviews included customers suffering hardship, customers that would benefit from usage alarms, and customers that would benefit from additional billing information.

Information from smart water metering will allow for much improved and more detailed customer segmentation than is possible with the very limited information that is obtained through the current accumulation metering. This could potentially allow for appropriate services to be tailored to each segment's needs, and priced accordingly. It may also allow for targeting of different price-service-security value propositions in the future. Smart water metering can therefore allow Water Authorities to be more proactive in managing these customer segments.

In summary, smart water metering may provide some qualitative benefit to Water Authorities and to customers in relationship management.

5.1.6 Mapping Customer Impacts and Benefits to Implementation Options

The customer impacts that have been described here, and which are summarised in Section 5.1.7 below, can result in benefits under Implementation Options 2 to 6, where the availability of pulse or interval data would allow customers to monitor their water usage and diagnose possible areas of leakage.

It is also reasonable to assume that providing customers with direct access to their consumption data through the Home Area Network (Implementation Options 3 - 6) will allow customers to have greater levels of empowerment than if the customer only receives this information on a retail bill. Provision of this information on a daily basis to the Water Authority would also provide improved benefits as compared to provision of this data on a weekly basis.

5.1.7 Summary of Qualitative Customer Impacts

Several potential customer impacts from smart water metering exist as follows:

- The most significant qualitative customer impact comes through the ability of smart water metering to provide greater information to customers in relation to their consumption, which enables them to make informed, proactive decisions about their water usage on a regular basis.
- The second most significant qualitative customer impact through the ability of smart water metering is to provide information to customers that allow them to identify household leakages far more easily than with accumulation metering. Additionally, smart water metering can provide incentives for customers to rectify identified leaks through innovative tariff structures.
- Smart water metering may also provide additional beneficial customer impacts in the areas of innovative water retail tariffs, supporting more frequent and accurate customer billing, or enhancing customer relationship management.

Accordingly, the benefits increase progressively between Implementation Options 2 and 4, and then remain the same for Implementation Options 5 and 6.

5.2 Societal Impacts

The main social impacts considered here are:

- Social equity; and
- Social stress (currently induced through prolonged periods of reduced rainfall and lack of available water as a result).

5.2.1 Social Equity

Various social equity areas were discussed with Water Authorities and various industry stakeholders. The key findings of this discussion are as follows:

- *Water restrictions:* Smart water metering could be of value to the extent that it (preferably) supports the removal of water restrictions, or (less preferably) the enforcement of water restrictions if water restrictions have to be retained. Smart water metering can support the removal of water restrictions by providing a range of alternative mechanisms to stimulate consumption reduction, including direct communication, provision of individual usage and usage trends, information and pricing signals. Some of these are discussed in the Literature Review (refer **Appendix A**). Alternatively, smart water metering can support the enforcement of water restrictions through the ability to monitor each household's usage and therefore identify water infringements. Today, restrictions aim to ensure the security of urban water supplies, and prevent the need for consumer price rises. Water restrictions rule out consumer price volatility, by replacing the demand signal that a market-driven scarcity price would send. However, the Australian Bureau of Agricultural and Resource Economics (ABARE) have shown that restrictions are a relatively inefficient method of demand management: there are inconvenience costs, efficiency losses and a requirement for substantial enforcement effort. Restrictions also do not address the supply side of the market, where artificially low water prices continue to discourage private investment in water supply capacity.
- *Tariff structures:* Smart water metering is a fundamentally important mechanism to allow for appropriate pricing and customer segmentation through innovative tariff structures that are both more cost-reflective and much more customer-reflective than those that currently exist.
- *Re-distribution of funds:* Those who are willing and able to pay for water to fill pools or for extensive outdoor watering are at the moment making substantial investments in ground water, rainwater storage, recycled water or water cartage, outside the water mains system. The funds that are expended on these investments only benefit those making the investments; the funds are not being used to improve the water system for other consumers or to provide general societal benefit. When more water is available, it may be possible to allow the filling of pools or extensive outdoor use, while measuring this water usage through smart water metering, and charging on a 'user pays' basis. The resulting income would then be available to fund investments in the water system that might benefit society in other ways.

- *Inter-generational equity:* Looking forward, our generation has a responsibility to subsequent generations to secure a sustainable supply of water and to provide reliable infrastructure to support our water resources for the future. This underpins inter-generational equity. Smart water metering could provide better information to influence long-term water policy and vision, which may provide better inter-generational equity.
- *Body corporate charges:* Water customers living in housing with services managed under body corporate arrangements (communal housing, apartments, flats, etc.) are often not individually charged for their own consumption, but instead share a total body corporate metered quantity. Such arrangements 'socialise' the cost across all customers exposed to the communal charges, creating winners and losers. The arrangements also substantially decrease the incentives on individual customers to manage their consumption, and opportunities for individual customers to be given information on their usage and monitor their consumption against targets are also lost. Tenants in these arrangements also do not see or pay for the consequences of their own consumption; where the property is not separately metered the landlord is unable to pass on the cost of the water consumed at the property to their tenant. Metering of individual consumption would eliminate the inequities that arise under these body corporate circumstances. Residents and owners of existing housing that does not have individual metering are unlikely to adopt individual metering, because of the cost of retro-fitting. In some new developments, particularly multi-storey developments and other types of gated communities, there can be problems for the meter reader to gain access to individual meters that measure the individual consumption of each separate property in the development. Smart water metering provides a solution to these problems, and is thus an enabler of the metering of individual properties to provide the societal benefits that result from individual metering. Smart water metering is already being adopted in some new developments as the most cost-effective and efficient means of capturing meter data from the individual meters in the development.

5.2.2 Social Stress

Supply shortages have resulted in a need to implement restrictions on the use of water, particularly for what are considered to be discretionary uses. Some approaches have been introduced to mitigate the effects, including, for example, offset programs. Smart water metering enables a broader scope of approaches to be trialled and implemented, which could provide the potential to stimulate innovation and achieve positive outcomes beyond the confines imposed by accumulation metering.

Discussions with the Water Authorities and various stakeholders identified that removing restrictions on use of water for private and public urban outdoor locations (i.e. parks and gardens, sports grounds) can reduce social stress, and provide health benefits by enabling more physical activity which improves physical health and fitness and can help to reduce obesity. Social activity is also beneficial to mental health.

During one interview, a Water Authority cited an example of carting water to a local sporting club to allow them to water their grounds, and allow the club to continue to operate in the interest of promoting community interaction and a reduction of social stress. This example demonstrates the price-service-security value proposition that was required by the sporting club in question. Smart water metering could enable more options to be developed to provide the desired outcomes.

5.2.3 Mapping Societal Impacts and Benefits to Implementation Options

The societal impacts that have been described here, and which are summarised in Section 5.2.5 below, can result in benefits under Implementation Options 2 to 6, where weekly or daily pulse or interval data will provide greater benefits in relation to the removal or enforcement of water restrictions. It is likely that the provision of daily data will result in greater benefits than weekly data, and therefore the greatest benefits will be provided under Implementation Options 4 to 6.

5.2.4 Summary of Qualitative Societal Impacts

It is likely that the societal benefits from smart water metering will be smaller than the customer benefits. The main qualitative societal impact comes from (preferably) supporting the removal of water restrictions, or (less preferably) the enforcement of water restrictions if water restrictions have to be retained. Other societal benefits may arise through re-distribution of funds, equity in body corporate charges, inter-generational equity, and a reduction in social stress.

5.3 Policy Impacts

The main policy impacts considered in this study were:

- Development of customer segmentation policies; and
- Policy development through customer research.

5.3.1 Development of Customer Segmentation Policies

Smart water metering allows the establishment of more sophisticated customer segmentation policies, but only related to consumption.

For example, discussions with stakeholders considered whether smart water meters could be used to support the identification of customers in hardship. However, given the range of factors that cause customer hardship, it was not considered that smart water metering would provide any appreciable benefit in identifying those customers. It was acknowledged that smart water metering could prevent customers from getting into hardship, to the extent that smart water metering provided timely information to monitor consumption and identify leaks and other high usage factors in time for the customer to remedy them before experiencing hardship.

Smart water metering could also be used to provide better information on the consumption levels and patterns of customers once they are identified as being in hardship. This information may be used to provide more focused advice and assistance to these customers to try to alleviate hardship.

More broadly, smart water metering increases awareness of actual usage of water, and the information gained from smart water metering can assist generally in the development of policy to support different customer segments and therefore different price-service-security value propositions.

5.3.2 Policy Development Through Customer Research

Smart water metering could be used to support pricing and behavioural trials to obtain more information on customer behaviour, scarcity pricing, price and income elasticity and willingness to pay in order to support future policy development. Indeed, given the wealth of information and data that smart water metering would provide, it is certain that if it were installed the metering would be used for this purpose, as has been the case where smart metering has been installed in the electricity industry. Smart water metering could support the water industry, government and academic research to improve the evaluation of results and to assist in the development of appropriate policy.

Sample research can provide information on customer behaviour in general and by segment. More extensive research within a geographical area can provide information on where the network demands are located, to assist in network operational management and investment planning. Sophisticated customer research with demographic information and their relevant data such as sizes of properties and gardens can also be extrapolated based on other data sources (such as census and ABS data) to provide state-wide pictures of behaviour in all areas, even if sampling research is more limited. Appropriate research could explore how different groups, including vulnerable, low income and disadvantaged consumers, would benefit from smart water metering. It could be facilitated through a reciprocal learning process between businesses and consumers.

The Literature Review (refer **Appendix A**) demonstrates that the water industry's knowledge of scarcity pricing, price and income elasticity, willingness to pay for smart metering, and the influence of smart water metering in all of the above areas is incomplete and inconclusive. This is largely a factor of the paucity of information that is available from the currently installed accumulation meter infrastructure.

Where it is implemented, smart water metering should be used to support pricing and behavioural trials to obtain more information on customer behaviour in each of the aforementioned areas. Such trials should also serve to confirm and to help quantify the impacts of smart water metering in all the qualitative areas that are discussed in this report section.

5.3.3 Mapping Policy Impacts and Benefits to Implementation Options

While implementation of AMR (Implementation Option 1) would provide more information than is available today, this information would remain at an aggregated level, and would not be particularly more valuable for policy development than the information that is available today.

However, the availability of pulse or interval meter data, and making this data available to the customer, as provided in Implementation Options 2 to 6, is considered to be particularly valuable to improving policy development.

5.3.4 Summary of Qualitative Policy Impacts

Several potential policy impacts from smart water metering exist as follows:

- Information from smart water metering could assist in customer segmentation, and could support the water industry, government and academic research to improve the evaluation of results of trials and to assist in the development of appropriate policy; and
- The rich information available from smart water metering would most likely be used to improve the water sector's understanding of scarcity pricing, price and income elasticity, willingness to pay for smart water metering and other factors that influence public policy development.

5.4 Environmental Impacts

The environmental impacts considered in this study were:

- The water cycle and hydrology;
- Water industry carbon footprint; and
- Urban landscape.

5.4.1 The Water Cycle and Hydrology

During the interviews, several stakeholders mentioned the changes to the environment that have occurred with reduced rainwater. Step changes have been observed in the hydrology of catchment areas, with consequences for water flows in rivers and other water carriers. When water flows are reduced, the water can become more polluted, through not being adequately flushed through the system.

Reduced water flows also change the hydrology so that when it does rain the water capture rate is lower. This creates a vicious circle from which it is difficult to break.

If smart water metering assists in reducing household water usage, decreases water leakage, increases the efficiency with which water is used, or helps in the appropriate use of a range of water supply sources (i.e. water tanks and water recycling), it will leave more water available for environmental purposes, to improve the liveability and the health of the environment. In general, better management of downstream water supply and usage should lead to better management of upstream resources, including rivers and other environmental flows.

5.4.2 Water Industry Carbon Footprint

This section discusses some ways in which smart water metering may reduce the carbon footprint of the water industry. It is recognised that this is not a full carbon footprint analysis of roll-out of smart water metering: a full analysis would require consideration of other carbon footprint impacts, including the lifecycle costs of earlier meter replacement. A full carbon footprint analysis would therefore go far beyond the scope of this report.

Smart water metering may reduce the carbon footprint of the water industry through the following improvements:

- *Reduced water pumping through more efficient water use*: If smart water metering improves the efficiency of water use, there may be a reduction in the requirement for pumping of water and a consequential reduction in electricity demand. This would reduce the carbon footprint of the water industry. More efficient water use may also lead to a consequential reduction in the carbon footprint attributable to water treatment if this reduces the energy requirement for treatment, as well as treatment chemicals. Reductions in the carbon footprint from more efficient water use may go some way to offsetting increases in the carbon footprint resulting from operation of the proposed desalination plant.
- *Reduced water pumping through reduced water leakage*: Smart water metering may support reduced pumping through better leakage identification. Smart water metering may therefore reduce the need to treat and pump water that is subsequently not used, with similar environmental benefits.
- *Reduced sewerage pumping*: If smart water metering helps identify where non-potable water could be used at a local level, this could lead to a reduction in the energy required to pump sewerage over large distances in favour of local treatment and recycling, hence a reduction in the carbon footprint of sewerage pumping. This benefit is dependent on the energy use and carbon footprint of the avoided sewerage pumping, as against the need to use energy to recycle water and to then transfer and distribute the recycled water in a separate pipe systems.
- *Reduced vehicle travel*: Smart water metering would also reduce vehicle travel necessary for manual meter reads. Distances travelled by meter readers can be quite significant in regional areas. This will reduce the carbon footprint from the fuel and transport requirements that are no longer necessary to support meter reading.

South East Water reported that its Eco-Pioneer Study had shown that customers wanted to know how they could reduce the carbon footprint of their water consumption, and smart water metering can assist in that area.

5.4.3 Urban Landscape

Removing restrictions on use of water for private and public urban outdoor use (parks and gardens, sports grounds) can improve the urban landscape, and have environmental benefits that come in several forms as follows:

- The environmental benefit from the trees and plants themselves contributing to absorption of carbon dioxide. A model[4] used by several cities to value an urban tree was discovered during the Literature Review, but was not included in our study (the Literature Review can be found in **Appendix A**); and
- A pleasant urban environment consisting of parks and sports grounds makes a positive contribution to health and may reduce social stress in general (as is discussed in Section 5.2.3 above).

However, it is unclear to what extent smart water metering may free up water for other uses; and it was noted during the interviews that new water sources (i.e. via desalination) may achieve this before smart water metering is ever implemented.

5.4.4 Mapping Environmental Impacts and Benefits to Implementation Options

Stakeholders agreed that the most significant environmental benefit due to smart water metering would accrue through consumers having access to more water consumption information. The resultant increased efficiency in water consumption could lead to reduced water and sewerage pumping, which will ultimately translate to reduced carbon footprint. An environmental benefit is therefore provided in Implementation Options 3 to 6, where consumers have access to real time consumption information via in-house communications. This benefit would, however, be small.

5.4.5 Summary of Qualitative Environmental Impacts

Several small environmental impacts from smart water metering exist as follows:

- Improved management of downstream water supply and usage through smart water metering should lead to improved hydrology, and better management of upstream resources, including rivers and other environmental flows;
- Reductions in the carbon footprint of the water industry through decreases in water and sewerage pumping (as a result of more efficient water and wastewater use, and reduced water leakage), and reduced vehicle travel for manual meter reads; and
- The removal of water restrictions for private and public urban outdoor use, which ultimately promotes improved urban landscapes of parks and sports grounds.

[4] See for example Peter Thyer's Tree Valuation Website at www.peterthyer.com.

5.5 Summary of Qualitative Analysis

Table 1 below pictorially presents the findings from the qualitative analysis against each of the four impact areas, and at the overall level.

Table 1: Summary of Qualitative Analysis

	1 Weekly AMR Services	2 Weekly Pulse Meter Data Collection	3 Weekly Pulse Meter Data Collection plus In House Display	4 Daily Pulse Meter Data Collection using Electricity AMI plus In House Communications	5 Daily Interval Meter Data Collection using Electricity AMI plus In House Communications	6 Daily Interval Meter Data collection using Water AMI plus In House Communications
Customer Benefits	○	◔	◑	◕	◕	◕
Societal Benefits	○	◔	◔	◑	◑	◑
Policy Benefits	○	◑	◑	◑	◑	◑
Environmental Benefits	○	○	◔	◔	◔	◔
Overall Qualitative Benefit	○	◔	◔	◑	◑	◑

Table Notes

1. *Under each category of benefits shown here, a more detailed list was developed, validated and assessed in consultation with water industry stakeholders;*
2. *Each individual benefit was assessed for the value it would bring to Victorians collectively, and for how heavily it depended on each potential level of smart water metering functionality; and*
3. *The qualitative scores shown here reflect a summary valuation of the many benefits under each category.*

As would be anticipated, the qualitative benefits from smart water metering increase as the availability of comprehensive metering data to the customer and the Water Authority increases. Based on the interviews conducted, there is no increase in the qualitative benefits arising from smart water metering with the change from pulse metering at Implementation Option 4 to interval metering at Implementation Option 5. Additionally, customer empowerment, social benefits and policy benefits are the main qualitative benefits that are realised in Options 3, 4, 5 and 6. In particular, customer empowerment and social benefits tend to increase with in-house communications.

6 Conclusions

6.1 Context: The Victorian Urban Water Sector

Over the next 30 years the Victorian Urban Water Sector is likely to become increasingly complex and less certain. The degree of complexity will be shaped by policy decisions that are yet to be made, and it is difficult to predict what the Victorian Urban Water Sector will look like in 30 years time.

- It is generally accepted that stakeholders in complex and uncertain environments need advanced risk and value management techniques and rely on sophisticated and accurate data to support these techniques. The degree of granularity and frequency with which data is made available increases as the complexity of the environment increases. .

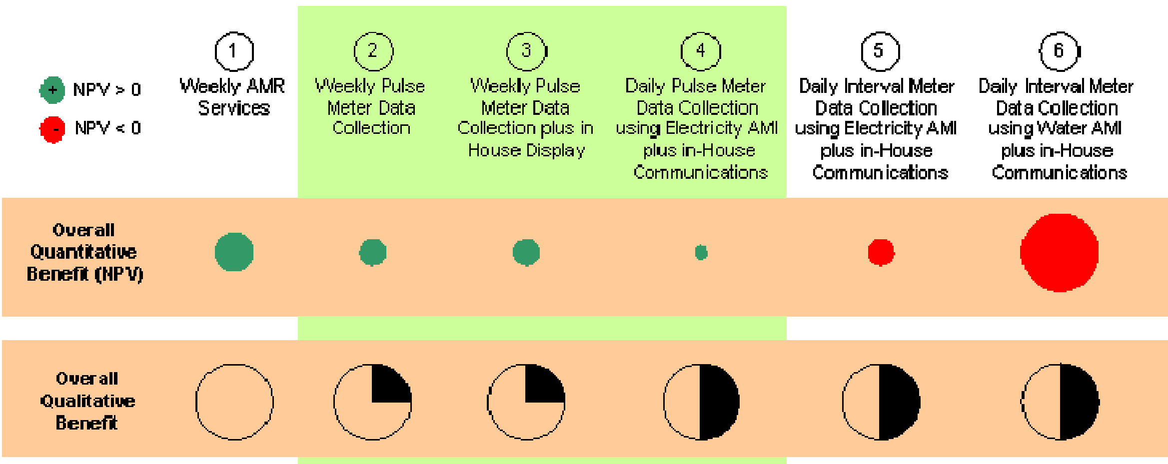
The relevance of smart metering to the Victorian Urban Water Sector can be summarised as follows:

- Metering that is able to deliver more comprehensive data more frequently than is available today, is likely to have a role in the future Victorian Urban Water Sector;
- The degree of sophistication of the water sector, hence the sophistication of the metering data to support this, is yet to be determined; and
- As water consumers become more sophisticated and interested in their water consumption, they are likely to demand more information and 'retail products' that better match their usage. Smart water metering may be relevant to supporting the needs of these consumers.

6.2 Quantitative and Qualitative Analysis

Table 2 below presents the combined quantitative and qualitative analyses pictorially.

Table 2: Combined Quantitative and Qualitative Analysis



Interval metering is comparatively more expensive than pulse metering as the meter is required to constantly monitor the water flows through the meter and record this volume at the expiration of the metering interval.

It is notable that by using a fine pulse quantum (say one to five litres) and analysing the timestamps of these pulses, pulse metering data can be used to approximate interval water metering data and hence deliver similar benefits.

This table indicates that:

- On the strengths of the quantitative analysis alone, all businesses in the Victorian Urban Water Sector should, as a minimum be considering the deployment of AMR Services (Implementation Option 1), but this would provide minimal qualitative benefits in comparison to smart water metering options.
- On the basis of the current costs of interval metering collection (including the cost of interval meters and the IT systems to support these) none of the smart water metering options involving the deployment of interval meters (Implementation Options 5 and 6) are warranted because the additional metering and IT system costs do not provide additional qualitative benefit over pulse metering based smart water metering.
- Each of the smart water metering options involving pulse metering (Implementation Options 2, 3 and 4) warrant further detailed consideration by the Victorian Urban Water Sector businesses as the financial benefit for each quantitative analysis was reasonably positive and these were supported by reasonable overall qualitative benefits. Furthermore, the sensitivity analysis for each Implementation Option demonstrated robust finally positive values for all variables.
- Given that the quantitative analysis was based on an extrapolation of the current water sector environment over a 30 year forward period and specifically excluded any impacts from the implementation of a water market in any form, if further investigation of either of these Implementation Options demonstrates a positive business case for smart water metering, then any consideration of benefits and costs arising from the implementation of a water market does not have to include the costs of smart water metering.

Provided that any further analysis of the likely costs and benefits of Implementation Options 2, 3 and 4 continues to demonstrate a positive financial benefit, there is no need to consider the additional costs and benefits that would arise from the implementation of a water market, in any form, in the decision for whether or not to proceed with smart water metering.

Should it be possible to make a positive commitment to smart water metering without reference to the implementation of a water market in Victoria, then it also holds that any decision to implement a water market can be made with the expectation that frequent, granular metering data (as defined by the relevant implementation of smart water metering) will be available to the participants in the water market in the defined form at no incremental cost.

A significant benefit to the analysis of water market options will be that the Water Authorities in the water market will have access to reasonably sophisticated metering data as a risk management tool which will enable consideration of sophisticated water market options.

6.3 Recommended Next Steps

6.3.1 Further Analysis of Pulse Based Smart Water Metering

Businesses in the Victorian Urban Water Sector should consider undertaking further detailed analysis of Implementation Options 2, 3 and 4 in order to better understand pulse based smart water metering as follows:

- The detailed business requirements of each of the options;
- The specific operation of each of the options;
- The functional and technical requirements of each element necessary to support each option, including the requirements for the pulse meters, the metering data collection equipment, and the ZigBee™ elements necessary to provide the customer with access to the metering data;
- The costs of each of the options; and
- The project resources necessary to implement each option.

Consideration should be given to the level of industry cooperation appropriate for the most efficient implementation of each option, including consideration of joint procurement of metering equipment and, where relevant, joint negotiation of access to critical infrastructure.

Determination of the relevancy of shared services, such as pulse meter data management, should also be investigated during this analysis.

This analysis would be desk and research based and would be most efficient if performed on a cross industry basis with open and transparent sharing of information.

As a minimum, the business requirements and cross industry operations analysis should be completed as a desk based 'Define/Conceptual Design" activity before any field trials of smart water metering commence.

6.3.2 Victorian Urban Water Sector Input to ZigBee™ Smart Energy Profile

Businesses in the Victorian Urban Water Sector should also urgently consider making a submission to the ZigBee™ Alliance to ensure that the Smart Energy Profile includes provision for:

- Pulse and interval water meters (including data loggers installed as after market add-ons to existing water meters) to be included as devices that can 'pair' with an electricity meter and become part of the Home Area Network that is controlled by the electricity meter;
- The collection of pulse or interval water metering data from a pulse or interval water meter (including data loggers installed as after market add-ons to existing water meters) via the electricity meter; and
- Communication of pulse or interval water metering data from a pulse or interval water meter (including data loggers installed as after market add-ons to existing water meters) via the Home Area Network to another device paired with the water meter.

6.3.3 Quantification of Qualitative Benefits of Smart Water Metering Through Market Research

The qualitative analysis indicated that a number of customer benefits would accrue with increasing value as metering data became more granular and was provided to customers and Water Authorities more frequently. In particular, the analysis indicated that customers would become more involved and empowered from access to pulse based consumption information via the Home Area Network and that this would lead to customers using water more efficiently or being actively involved in the identification of leaks. The information on which these assessments were based is scant.

This Literature Review **(Appendix A)** has shown that the water industry's knowledge of price and income elasticity, willingness to pay and scarcity pricing for smart water metering, and the influence of smart water metering in these areas is incomplete and inconclusive.

As a minimum, market research with a representative sample of customers should be conducted to quantify how customers would value the information provided by smart water metering and how they believe they would respond. Depending on the complexity of the market research conducted, this information could provide deep insights into the price and income elasticity, and willingness to pay for smart water metering. Additionally, as metering technology becomes available at reasonable cost, formalised smart water metering trials should be conducted to validate price and income elasticity, and willingness to pay market research (refer Section 6.3.4).

Market research into the likely customer response to different pricing mechanisms such as scarcity pricing or variants in retail water tariff structures (different block tariffs, seasonal tariffs, etc) which can be supported by pulse metering, should also be conducted to quantify the societal and policy benefits that were indicated as being possible through the qualitative analysis. Where this research validates a reasonable likelihood of customer response to scarcity pricing or variants in the retail water tariff structure, subsequent smart water metering trials should also be undertaken to validate the impact of these different pricing mechanisms on water demand and efficiency of water consumption (refer Section 6.3.4).

6.3.4 Smart Water Metering Trials

Once the Analysis of Pulse Based Smart Water Metering (refer Section 6.3.1) and the Quantification of Qualitative Benefits of Smart Water Metering through Market Research (refer Section 6.3.3) are concluded, Water Authorities in the Victorian Urban Water Sector should commence coordinated smart water metering trials to validate the findings of:

- The quantitative analysis contained within this report and further developed through the desk based analysis recommended in Section 6.3.1, particularly in relation to leakage management (i.e. network and household) and technology (i.e. meters, ZigBee™ communication modules and IT systems); and
- The qualitative analysis contained in this report and subsequent market research recommended in Section 6.3.3, particularly in relation to customer empowerment, price and income elasticity, willingness to pay and different pricing mechanisms.

Trials that should be considered include:

Network and household leakage identification trials:

- To determine the effectiveness of smart water metering for identifying network and household leakages; and quantify the extent of leakage reduction.

Technology trials:

- To establish the pros and cons of different meters, communication modules and IT systems and to identify the most appropriate smart metering technology.
- To develop and test Water Authority internal processes for dealing with smart water metering.
- Technology trials of Implementation Option 2 could commence immediately as this technology is available today.

Customer responsiveness trials:

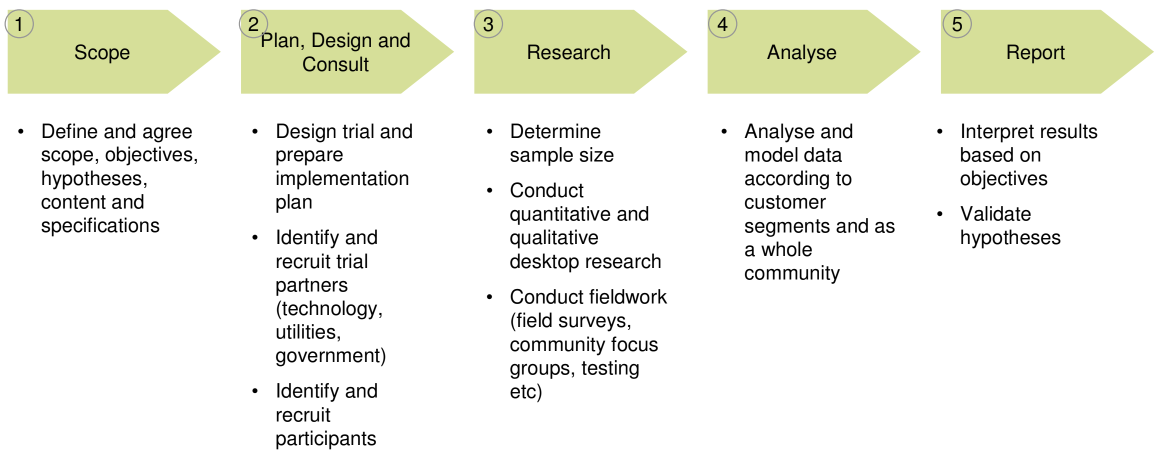
- To establish the change in consumer behaviour towards the consumption of water through the provision of consumption data from smart water metering.
- To establish the change in consumer behaviour towards the consumption of water through different pricing mechanisms (different block tariff arrangements, seasonal tariffs, etc).

Elasticity and willingness to pay trials

- To determine how price and income elasticity might change by different customer segment, by consumption level or as the price of water becomes significantly higher (or lower).
- To determine the willingness to pay of the different segments of the community for their smart water metering technology, or for their water consumption.

A generic approach towards conducting smart water metering trials (which can also be applied to market research) is depicted in the Figure 9 below.

Figure 9: Generic Approach to Conducting Smart Water Metering Trials



To maximise the efficiencies and benefits of these trials, consideration should be given to cooperating with Water Authorities in other States around Australia to test the most significant assumptions and develop more refined Implementation Options for evaluation. This could be supported by the establishment of a water industry taskforce consisting of Government and Water Authority representatives which would manage trials and to develop appropriate policies for information sharing and future implementation.

6.3.5 Use of Market Research and Smart Water Metering Trials for Policy Development

Where market research and smart water metering trials are undertaken, or rollout and operation of smart water metering commences, the data that is generated from market research, smart water metering trials or actual operation should also be made available to government for use in the development of water market policy decisions.

Glossary

Item	Definition
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AMI	Advanced Metering Infrastructure
AMR	Automated Meter Reading
CPI	Consumer Price Index
CPP	Critical peak pricing
C/B	Cost / Benefit
DPC	Department of Premier and Cabinet
DSE	The Department of Sustainability and Environment
ESC	Essential Services Commission
HAN	Home Area Network
IT	Information Technology
MCE	Ministerial Council on Energy
MHC	Marchment Hill Consulting
NPV	Net present value
RF	Radio frequency
RFI	Request for Information
SWM	Smart Water Metering
TOU	Time of use
VCEC	Victorian Competition and Efficiency Commission
WSAA	Water Services Association of Australia

Appendix A: Literature Review

Smart Water Metering Cost Benefit Study

Literature Review

Final Version

February 2010

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Executive Summary

The Department of Sustainability and Environment (DSE) has undertaken a Study to investigate the potential costs and benefits of implementing Smart Water Metering (SWM) in Victoria. As part of this Study, the DSE conducted a review of internationally available literature covering:

- Water Demand – Scarcity Pricing, Elasticity and Willingness to Pay;
- Water Industry Reform Options; and
- SWM and Automated Meter Reading (AMR) projects, in Australia and Internationally.

Water Demand

In times of water shortage governments have opted to use water restrictions, rather than price, to balance supply and demand because use of the economically efficient price of water has not always been politically feasible. Water restrictions are considered a relatively inefficient method of demand management, as they drive inconvenience costs, efficiency losses and a requirement for substantial enforcement effort.

The use of scarcity pricing instead of water restrictions is considered by some in the water industry to be ineffective due to the infrequency of billing, consumers' limited knowledge of the price of water, and its possible impact on lower socio-economic consumer groups. However, the National Water Commission believes scarcity pricing warrants further investigation as a tool for balancing supply and demand.

The limited price and income elasticity data that is available indicates that water is an inelastic good, and that elasticity may differ between water used for indoor and for outdoor purposes. It is unclear how elasticity might change as the price of water becomes significantly higher (or lower).

The willingness to pay for smart water meters is difficult to assess directly, as there is little existing literature available, and willingness to pay is dependent on time, geography, functionality of the specific meter on offer, and the values and priorities of the community who are being asked to pay for it.

This review has shown that the water industry's knowledge of scarcity pricing, price and income elasticity, willingness to pay for SWM, and the influence of SWM in these areas is incomplete and inconclusive.

Water Industry Reform Options

The Victorian Competition and Efficiency Commission (VCEC) recently commissioned an enquiry on pro-competitive reform options for the metropolitan retail sector. The enquiry considered a range of industry reform options including competitive sourcing of water supplies and retail services, third party access, establishment of a water grid manager and tariff reform. The applicability of each reform option to the future of the Victorian Urban Water Sector has not yet been determined.

What is known is that the Victorian Urban Water Sector will be a complex environment that will rely on more sophisticated data than today.

SWM may have a role to play in future industry policy and reform:

- Metering that is able to deliver more comprehensive data more frequently than is available today, is likely to have a role in the Victorian Urban Water Sector in the future; and
- If a 'service provider' or 'retail' market is introduced in Victoria then SWM (that is smart water metering at the consumer level) may be required.

SWM and AMR Projects

The Australian and International Water AMR programs outlined in this Study have found that leakage and tampering detection, network demand and asset management, water conservation, and customer interfaces (e.g. billing) all have the scope to be improved by AMR (in varying degrees).

The potential applications of SWM (i.e. water usage analytics and alerts, customer education, two-way communication) are not widely discussed, and there are few precedents from either the electricity or water industries to guide this Study.

2 Background

2.1 Introduction

The Department of Sustainability and Environment (DSE) has undertaken a Study to investigate the potential costs and benefits of implementing Smart Water Metering (SWM) in Victoria. This Study was driven by:

- The need to respond to the variety of challenges arising from climate change, infrastructure investment and population growth;
- Increased interest of many electricity, gas and water service authorities across the world in smart metering;
- The opportunity to significantly improve delivery of the urban water services and enhance other water efficiency initiatives through increasing customer awareness of their water use, empowering customers to better manage their consumption and providing valuable demand information to the Victorian Urban Water sector stakeholders;
- The need to evaluate whether smart water metering has the potential to play an important role in stimulating innovation in water management and the achievement of longer term Victorian water industry reform objectives; and
- An opportunity for the water industry to understand implications of the Victorian investment and capability of Smart Electricity Metering.

As part of this Study, the DSE conducted a review of internationally available literature covering:

- Water Demand – Scarcity Pricing, Elasticity and Willingness to Pay;
- Water Industry Reform Options; and
- SWM and Automated Meter Reading (AMR) projects, in Australia and Internationally.

2.2 The Victorian Water Context

The Victorian Urban Water Sector is facing a set of issues which, in aggregate, are unprecedented and are making the entire sector an area of public and community focus. These events include:

- A prolonged period of changes in rainfall patterns and the amount of rainfall which has significantly diminished reservoir storage levels;
- Extended and severe water restriction regimes as the primary tool to manage supply shortages;
- Debate around the effectiveness of current tariff pricing regimes at driving efficient water use; and
- Increased scrutiny on bulk water planning, water restriction policies and the price of water as a result of the above.

These events have driven an interest for identifying the potential for smart water metering to benefit the water industry and community.

2.3 The Victorian Electricity Context

Studies by the Victorian and Federal Governments have found that the potential benefits from implementing Smart Electricity Metering to approximately 10 million electricity customers across Australia will outweigh the costs.

The Ministerial Council on Energy (MCE) has commissioned the National Smart Metering Project to develop a national framework for Smart Electricity Metering. Prior to the MCE initiative, the Victorian Government, through the Department of Primary Industries, mandated the deployment of Smart Electricity Metering to all residential and small businesses in Victoria by the end of 2013, and a set of minimum Advanced Metering Infrastructure (AMI) Services that are to be made available to these consumers. The Victorian Government and participants in the Victorian electricity sector have established the Victorian AMI program to deliver the Smart Electricity Metering and enable the AMI services.

These Smart Electricity Meters include functionality that supports a Home Area Network (HAN) that connects devices within the customers premise and allows communications between these devices and from / to the electricity distribution business.

In the context of the Victorian AMI Program, a water meter could be considered as a Home Area Network (HAN) device. Therefore, the opportunity exists for the water industry to leverage off this investment and capability to deliver benefits to the Victorian Urban Water sector.

3 Water Demand – Elasticity, Willingness to Pay and Scarcity Pricing

3.1 Context of Water Demand in Australia

Water has historically been cheap in Australia, both in absolute terms and as a proportion of household income (refer Figure 1 and Figure 2 below). The current prices for water and wastewater services constitute just 0.67% of household expenditure – by contrast, energy in the form of electricity and gas accounts for 2.6%, food for 17% and housing for 15%.[1]

Figure 1: Comparative Cost of Water in Australia vs. Other Countries

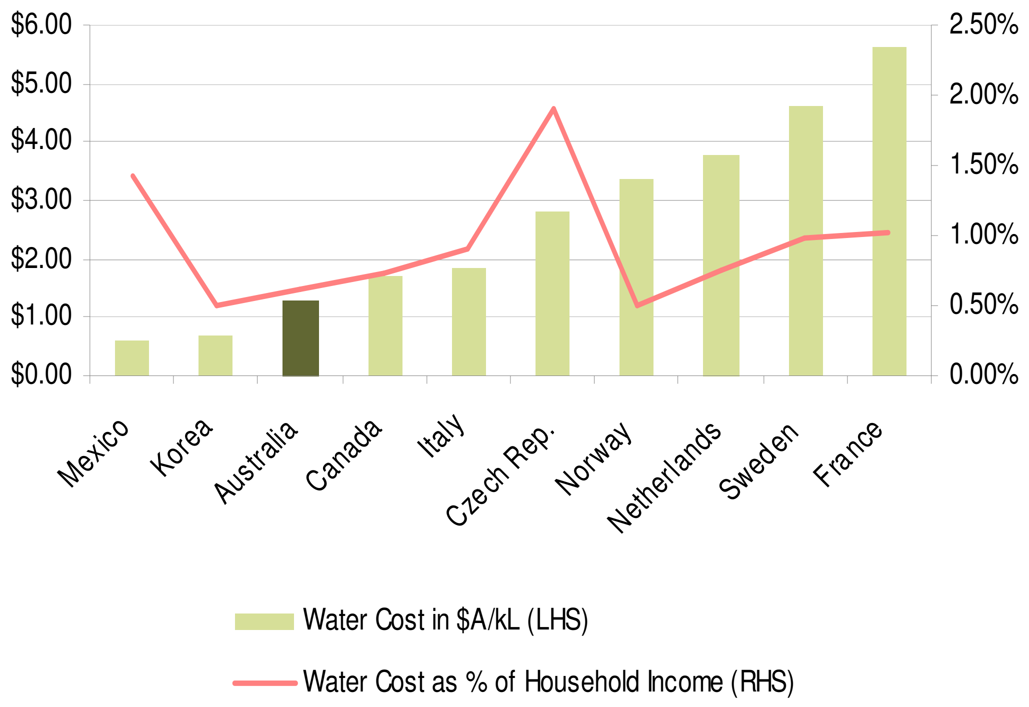
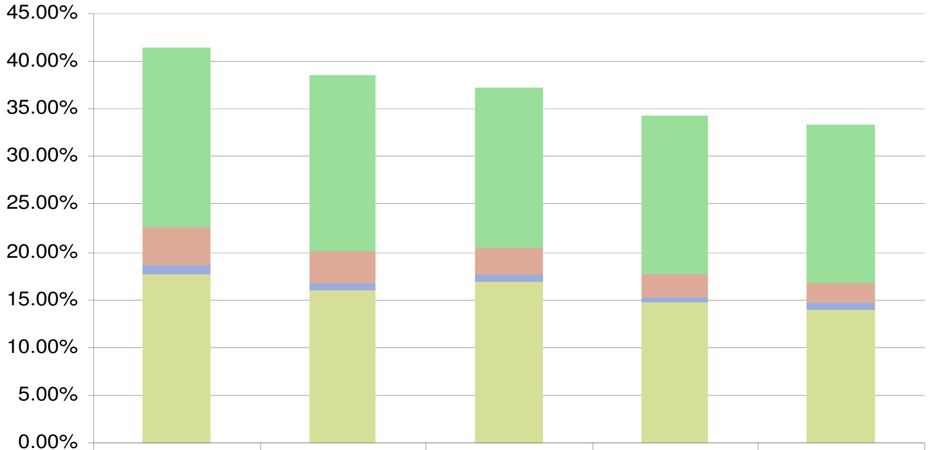


Figure 2: Water as a Proportion of Household Budget vs. Other Necessities



	Lowest Income Quintile	Second	Third	Fourth	Highest Income Quintile
Food	18.96%	18.51%	16.96%	16.65%	16.49%
Gas & Electricity	4.01%	3.35%	2.73%	2.36%	2.13%
Water	0.90%	0.74%	0.67%	0.63%	0.61%
Housing	17.70%	16.00%	16.98%	14.74%	14.10%

These figures signify that, despite whatever arguments may be made on moral terms concerning the equity (or inequity) of current water pricing arrangements, there is little argument to be made on financial terms. The cost impact of water, even to the most disadvantaged in the community, is vanishingly small, and so too is its effect on social equity as a whole.

3.2 Existing Management Plans To Manage Severe Reduction In Rainfall

Water supply planning in Victoria has hitherto aimed to balance supply and demand, based on normal water flows and the historical climate of the State. However, Australia's pattern of extreme variance in rainfall made it impractical for planners to create a drought-proof permanent system. It was understood that contingency measures would be required to cope with 1 in 20 year reduced rainfall events – representing roughly a 95% security of supply. Table 1 overleaf shows that in the 140 years from 1857 (when Yan Yean reservoir came on line) to 1996, Victoria experienced 10 such major rainfall reductions.

Victoria's short term reduced rainfall management plans were therefore intended to complement long term water supply planning under non-reduced rainfall conditions. Under a typical reduced rainfall scenario these plans might call for Stage 3 water restrictions to be applied for 12 months at a time and tapping additional sources such as groundwater or, as a last resort, water cartage.

Long term water supply plans, by contrast, called for large reservoirs with multi-year carry over capacity which would mitigate the impact of reduced rainfall. This proved effective insofar as short term (i.e. water restrictions) were not necessary during many of the reduced rainfall periods shown in Table 1 below.

Table 1: Historical Reduced Rainfall in Melbourne [2]

Major Reductions in Rainfall Experienced in Victoria and Around Melbourne	
1865-66	1967-68*
1914-15	1972-73*
1919	1976-78
1922-23	1982-83*
1938-39*	1997-*
1943-45	

* Water restrictions introduced in Melbourne

Historical water flow patterns had not prepared planners for the current levels of reduced rainfall, which have lasted from 1997 until now. Water restrictions were initially applied in 2002 with the expectation that, as in the past, they would be lifted within a few years at most. However, as the length and severity of the reduction in rainfall worsened, and many contingencies were successively triggered, restrictions became a permanent measure out of pure necessity.

Victoria is now in a phase of transition between previous strategies for managing the reduction in rainfall, and the strategies required for what is expected to be a very different future. DSE's water planning processes are now based on very different assumptions from those prior to 2006 which were based on an assumed continuation of the historical record (of climate and streamflow). In 2006 low, medium and high climate change scenarios were introduced into the planning process and also a scenario that involved the continuation of the persistently dry conditions from 1997 (which is about equivalent to medium to high climate change scenarios by the middle of the century). As a consequence, new sources of water supplies, such as desalination plants, are currently being implemented. Ultimately, the objective is to lift Victoria's current water restrictions (Stages 3 and 4) and eventually restore unrestricted water supply on a sustained and secure basis.[3]

However, there is a time lag between the current thinking of water planners and the implementation of their objectives. We can expect restrictions to persist until Victoria's sources of supply are sufficiently augmented, and the water industry structure reformed to accommodate them.

3.3 Scarcity Pricing

The price of residential water in Australia is set by regulators, and infrequently changed. Unlike other goods and services, the price of water does not rise and fall to reflect its scarcity. In times of water shortage, governments have opted to use water restrictions, rather than price, to balance supply and demand (IPART).

The price of water, at a given level of current demand, should ideally reflect the Long Run Marginal Cost (LRMC) of supplying an additional unit of water, over and above that current demand. The LRMC will in turn take into account the:

- Costs of each water business's long term infrastructure program;
- Impact of water restrictions and other demand management measures on projected demand;
- Available sources of water supply (for example, new desalination plants) and their respective costs; and
- Level of reserve capacity needed to ensure that water does not run out under any plausible scenario.

In practice, the economically efficient price of water has not always been politically feasible. Water, as the most essential of all goods, has a price that serves not only as a signal to consumers and producers, but also as an implicit policy instrument to ensure that it is affordable to everyone.

There are many options for scarcity pricing. Water could be priced in line with dam levels: rising when dams fall below critical levels and falling in the converse case.[4] Suggestions have been made, however, that scarcity pricing is less likely to be effective in the water industry due to the:

- Infrequency of billing, as consumers currently do not receive a price signal until up to three months after their water consumption;
- Consumer's lack of knowledge of the price of water consumed at any given point in time;
- Necessity of consuming a certain amount of water regardless of ability to pay: this being of particular concern when assessing the possible impact of scarcity pricing on lower socio-economic consumer groups; and
- Fact that because storage levels are a function of previous behaviour, scarcity pricing based on storage levels would penalise those who have consistently been water conscious as water saved is water stored.

Therefore, the argument goes, water is unlike other commodities such as petrol or food where the consumer is able to make a decision to consume based on the price signal.

However, it is possible to set water tariffs for consumers purchasing water from a retailer at a level that approximates the long run average market price of water on a wholesale market – electricity tariffs in Victoria are the closest analogue. Such tariffs could be both clear to the consumer and reflective of the costs of that water's supply. Ensuring the affordability of non-discretionary water use is equally possible today using policy instruments such as price-based direct subsidies, or by setting a low price for an initial block of each household's daily, weekly, or quarterly water usage, large enough to satisfy basic water requirements.

Today, restrictions aim to ensure the security of urban water supplies, prevent the need for consumer price rises and rule out consumer price volatility, by replacing the demand signal that a market-driven scarcity price would send. However, the Australian Bureau of Agricultural and Resource Economics (ABARE) has shown that restrictions are a relatively inefficient method of demand management: there are inconvenience costs, efficiency losses and a requirement for substantial enforcement effort. Restrictions also do not address the supply side of the market, where artificially low water prices continue to discourage private investment in water supply capacity.

The National Water Commission (NWC) recognises that continuous water restrictions are inequitable and are an inefficient mechanism for balancing supply and demand[5].

The NWC has encouraged improved water pricing to allow for urban water reform, emphasising the importance of the retail water price as it conveys price signals to customers and signals the need for investment in new supply resources.

With regards to scarcity pricing, the NWC supports further investigation in scarcity pricing in urban areas on the basis that it will be more effective in balancing supply and demand.

3.4 Price and Income Elasticity of Water Demand

Water is, throughout the world, an inelastic good: the price that consumers pay for it has very little effect on how much they consume.

Various studies have found wide-ranging price elasticity values for water. In Australia price elasticity values tend to centre around -0.3 to -0.4 in Australia (this implies that when the price of water increases by 100%, demand will drop by 30 - 40%).

Data on the income elasticity of water is scarce. In economic parlance, water is a "normal good" – when a consumer's income rises, they will spend some (but not all) of that additional income on increasing their water consumption. Based on available figures, it is expected that when income doubles, water demand will increase by 20 - 25%.

A summary of the findings' of various studies on water price elasticity and water income elasticity are presented in Table 2 and Table 3 respectively.

Table 2: Water Price Elasticity Estimates

Author	Source	Year	Location	Price Elasticity
Conley B	Price elasticity of the demand for water in Southern California', *The Annals of Regional Science*	1967	Southern California	-0.35 (Total) -0.24 (Indoor) -0.7 (Outdoor)
Warner R	*Water pricing and the marginal cost of water*	1996	Sydney	-0.13
Graham D, Scott S	*Price Elasticity & Sustainable Water Prices*	1997	ACT	-0.27
Dalhuisen J, Florax R	'Price and income elasticities of residential water demand: a meta analysis', *Land Economics*	2003	US	-0.41
IPART	*Investigation into Price Structures to Reduce the Demand for Water in the Sydney Basin, Issues Paper*	2003	Sydney	-0.3

<table>
<tr><th>Author</th><th>Source</th><th>Year</th><th>Location</th><th colspan="2">Price Elasticity</th></tr>
<tr><td rowspan="6">Water Services Association of Australia</td><td rowspan="6">WSAA – Pricing for Demand Management, Results for Melbourne</td><td rowspan="6">2003</td><td rowspan="6">Melbourne</td><td>Change in bill</td><td>Elasticity</td></tr>
<tr><td>-40-0%</td><td>-0.046 (Total)
-0.026 (Indoor)
-0.095(Outdoor)</td></tr>
<tr><td>0-20%</td><td>-0.493 (Total)
-0.395 (Indoor)
-0.857(Outdoor)</td></tr>
<tr><td>20-120%</td><td>-0.051 (Total)
-0.039 (Indoor)
-0.107(Outdoor)</td></tr>
<tr><td>-40-160%</td><td>-0.075 (Total)
-0.054 (Indoor)
-0.142(Outdoor)</td></tr>
<tr><td>Perth Study (28c – 62c)</td><td>-0.18 (Total)
-0.04 (Indoor)
-0.31(Outdoor)</td></tr>
<tr><td>Hoffman M, Worthington A, Higgs H</td><td>‘Modelling residential water demand with fixed volumetric charging in a large urban municipality: The case of Brisbane, Australia’, Australian Journal of Agricultural and Resource Economics</td><td>2006</td><td>Brisbane</td><td colspan="2">-0.61</td></tr>
<tr><td>Grafton Q, Kompas T</td><td>‘Pricing Sydney water’, Australian Journal of Agricultural and Resource Economics</td><td>2007</td><td>Sydney</td><td colspan="2">-0.35</td></tr>
<tr><td>Grafton Q, Ward M</td><td>Prices versus rationing: Marshallian surplus and mandatory water restrictions</td><td>2007</td><td>Sydney</td><td colspan="2">-0.17</td></tr>
<tr><td>Olmstead S</td><td>Reduced-form vs. Structural Models of Water Demand Under Nonlinear Prices', Journal of Business and Economic Statistics</td><td>2007</td><td>US</td><td colspan="2">-0.609</td></tr>
<tr><td>ABARE</td><td>Urban Water Management</td><td>2008</td><td>Australia</td><td colspan="2">0 (Essential)
-0.45 (Discretionary)</td></tr>
<tr><td>Grafton Q</td><td>Determinants of Residential Water Demand in OECD Countries</td><td>2008</td><td>OECD(10)</td><td colspan="2">-0.56</td></tr>
<tr><td>Xayavong V, Burton M, White B</td><td>Estimating Urban Residential Water-Demand With Increasing Block Prices</td><td>2008</td><td>Perth</td><td colspan="2">-0.82 (Indoor)
-1.37 (Outdoor)</td></tr>
</table>

Table 3: Water Income Elasticity Estimates

Author	Source	Year	Location	Income Elasticity
Dalhuisen J, Florax R	'Price and income elasticities of residential water demand: a meta analysis', *Land Economics*	2003	US	+0.28
Olmstead S	Reduced-form vs. Structural Models of Water Demand Under Nonlinear Prices', *Journal of Business and Economic Statistics*	2007	US	+0.1865

Thomas and Syme (1988), in the first domestic water use study in Perth, measured household attitude towards water consumption, and water bills[6]. Selected households were then interviewed at a family level to assess their precise behavioural response to changes to water pricing when presented with a range of prices, the highest of which was three times higher than their current bill.

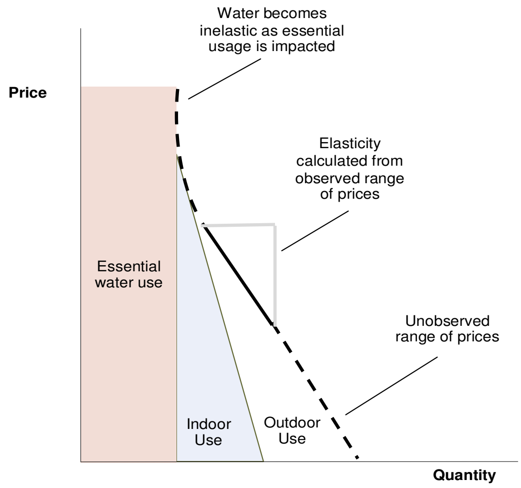
Based on the response, the authors were able to provide feedback on the amount of water saved and thus the changes in their water bill. The family could then revise their behavioural offers when they balanced the likelihood and costs for any water conserving efforts. The resultant overall price elasticity was low at that time (-0.18), with indoor use being a tiny (-0.04). External water use, however, was higher (-0.31). People who thought water was important for their lifestyle had a lower price elasticity (-0.14) than those who did not see it in that light (-0.52). The elasticity of a variety of individual components of water use was also estimated. The overall contingent valuation estimate was later validated by traditional longitudinal cost benefit estimation.

These studies lead to the consideration that elasticity will differ between water used for essential purposes, for other indoor use, and for outdoor use (some studies have found outdoor use to be relatively elastic). It seems that major price related savings may occur outdoors but since the majority of people regard home water use as important to their lifestyle (85%) and home gardening is still the most popular recreational activity in Australia. The advantage of such a behavioural approach is that the impacts of pricing on day-to-day activities can be measured as well as price elasticity which can help water planning and pricing policies. Smart meters would provide a valuable data platform for such analyses to be conducted.

Also, water elasticity has been examined within a range of "typical" prices, of the same order of magnitude as Australia's current price of $1-2 per kL. It is not clear how elasticity, or the effect of price on demand, might change as the price becomes significantly higher (or lower).

Figure 3 overleaf illustrates how observed value of elasticity (the gradient of the curve) may conceal different price responses for different water uses, and for unfamiliar price levels.

Figure 3: Characteristics of Water Demand Elasticity



3.5 Willingness to Pay for Water Infrastructure

The willingness to pay for smart water meters is difficult to assess directly: there is little existing literature available, and willingness to pay is dependent on time, geography, functionality of the specific meter on offer, and the values and priorities of the community who are being asked to pay for it.

As a proxy, what customers are willing to pay to gain more control over their use of water through other means could be considered. Indicative costs to achieve such control include:

- A report for the ACTEW Corporation by the Centre for International Economics assessed that an average Canberra household was willing to pay between $198 and $769 per year to avoid water restrictions, depending on their severity and frequency;
- Rainwater tank packages regularly cost between $1,000 and $3,000 and enable households to minimise the impact of water restrictions. The DSE statistics indicate that since January 2003, over 30,800 rainwater tank rebates have been provided to Victorian urban water customers. Of these, 5500 are large tank rebates which are connected to internal uses (toilet and/or laundry). In addition, over 1500 rebates have been provided for 'tank to toilet' connections of either existing tanks or for tanks that fall outside the size limit for large tanks; and
- Studies have found willingness to pay of $7 – 8 / kL for recycled water cartage, delivered to their homes.

It might be concluded that customers do value a secure water supply and their ability to decide how to use it, and value this much more highly than reticulated water's current price.

Smart meters do not increase the volume or security of water available to customers. However, they can empower customers with the information to manage their own consumption better than they can today, and may facilitate an environment where mandatory restrictions are replaced with a combination of price signals and voluntary water efficiency measures.

If a customer's willingness to pay is to be robustly assessed, the method of assessment needs to be carefully developed with the following principles in mind:

- An individual's willingness to pay will be a function of how SWM is implemented, as well as their capabilities;
- Respondents need to be informed of the benefits SWM will provide, what each will cost, and what the alternatives are;
- The potential negative amenity of smart metering needs to be considered along with the monetary costs;
- The context in which smart metering is being offered also needs to be considered. Some circumstances affecting willingness to pay (e.g. reduced rainfall and subsequent water restrictions) may change in the long term; and
- Different groups defined by socioeconomic, cultural, or geographic boundaries will differ in their respective willingness to pay – there is a danger of blurring or confounding their responses into a non-descript average.

4 SWM and AMR Projects

A number of Smart Water Metering (SWM) and Automated Meter Reading (AMR) projects were investigated so as to develop insight into typical costs and benefits of these types of projects. The selection of the projects investigated was based on a number of characteristics, including:

- Scale of the project;
- Climate conditions; and
- Project maturity, where projects that were either new or close to completion were preferred over those that were part way through.

There is growing momentum for SWM pilots and programs in North America with recognition of water retailer benefits including:

- Identification and reduction of water leakage;
- Improved asset management efficiency and effectiveness;
- Reduced cost of retail operations; and
- Changing consumer water efficiency and consumption attitudes and behaviour.

Within Europe, while Smart Electricity Metering investment is well-advanced and supported by demand management policy, SWM has not developed to nearly the same extent. Potential factors that may have influenced this current status are as follows:

- Water scarcity is less of a concern;
- Many areas are unmetered, and the introduction of water metering would be politically difficult at a consumer level and create an additional asset to be managed by water retailers; and
- Until now, there has been little evidence of governments taking the policy view that driving competition and innovation is necessary in European water industries.

In the UK, a number of local water businesses formed the Intelligent Metering Initiative, whose purpose is to help the water industry understand the potential value of smart metering. Since early 2008, the initiative has been studying meter penetration, AMR functionality and best practice implementations, approaches to leakage reduction, and potential tariff structures. Some of these water businesses have gone on to conduct their own small-scale AMR trials (note that a detailed study of these trials has not been undertaken as part of this report owing to lack of publically available information).

In November 2008, the UK government's Cave Review of Water Markets[7] signalled a new interest in competition and innovation in water markets, which may present an opportunity for larger scale SWM projects to be developed in the near future.

4.1 Water Metering Definitions

The past decade has seen an evolution of conceptual design of advanced or smart metering and its terminology. Driven by electricity investment, metering has evolved from interval meters with simple communications, to advanced or smart metering with an increased range of metering functionality.

Smart metering for the water industry will also extend beyond the capability of 'Automated Meter Reading' (AMR). Smart metering is expected to, as a minimum, establish more granular (within a day) water usage data, two-way communications between the water utility and the water meter, and potentially include communications to the customer (denoted 'Smart Water Metering').

With respect to a customer's household, SWM could enable:

- Recording of water consumption within a day;
- Remote meter reading on a scheduled and on-demand basis;
- Notification of abnormal usage to the customer and/or the water utility;
- Control of water consumption devices within a customer's premise; and
- Delivery of messages to the customer.

Analysis by the Water Services Association of Australia provides more detail on water retailer business requirements of smart metering[8].

The distinctions between various levels of metering are, in some cases, grey. However for the purposes of common terminology within this report the following metering definitions (refer Figure below) have been developed.

Figure 4: Metering Definitions

	AMR	Smart Water Metering (SWM)		
Traditional Metering	Automated Meter Reading (AMR)	Pulse/Interval Based Meter Data	Pulse/Interval Meter Data with ZigBee HAN	Pulse/Interval Meter Data with HAN and 2-way communications
• Mechanical Accumulation Meters • Manually read by pedestrian meter readers • Single consumption value per read	• Mechanical Accumulation Meters • Accumulation Data Logger with transponder • "Drive by" meter reading • Single consumption value per meter read	• Pulse or Time Interval Based Consumption Measurement • Pulse or Time Interval Based Data Logger with transponder • "Drive-by" or remote meter reading[1] • Multiple consumption values per meter read, including measurement of within a day consumption	• Pulse or Time Interval Based Consumption Measurement • Pulse or Time Interval Based Data Logger with transponder • "Drive-by" or remote meter reading[1] • Multiple consumption values per meter read including measurement of within a day consumption • Meter consumption data available to Home Area Network (HAN)	• Pulse or Time Interval Based Consumption Measurement • Pulse or Time Interval Based Data Logger with transponder • Remote meter reading[1] • Multiple consumption values per meter read including measurement of within a day consumption • Meter consumption data available to Home Area Network (HAN) • Water Retailer able to send messages to customer via HAN

[1] *Remote meter reading is required for on-demand meter reading*

4.2 SWM in an Australian Context

Australian water supply issues, driven by the reduction in rainfall, create the need to provide water consumption data in a form and at a frequency that allows for improved investment decisions and increased engagement with customer regarding their water consumption.

The energy sector has had some success in using smart metering to influence consumers through increased awareness of their consumption and changed behaviour, and capturing industry benefits from reduced investment in generation and network augmentation. These types of benefits might also be achievable in the water industry where, in general, consumer behaviour reflects the need to secure a limited resource and at the same time save money.

A survey of Australian consumers[9] highlighted their belief that ensuring adequate supplies of water for both consumption and the health of the environment is the most important issue in society. But the same results showed that 42% of individuals surveyed are unable to determine whether they are effective in reducing their own water usage. Therefore, consumers are likely to benefit from technology that allows them to monitor and understand their water usage, providing consumer education to establish a generational and societal change in attitudes towards water efficiency and consumption.

The Department of Sustainability and Environment (DSE) has implemented a number of SWM programs to encourage efficient water usage management[10]. The "Smart Metering of Top 200 Water Consumers in Melbourne" project, which commenced in October 2003, was targeted at the top 200 non-residential users of water to assist them in developing improved and effective water management plans. The DSE also implemented the "Smart Water Metering of Government / Institutional Sites" project to allow for and encourage the monitoring of water usage. Both projects have provided information that could be used for substantiating the benefits and costs of SWM and improving the management of water usage.

Many water utilities have implemented strategies for managing demand for water: metering, water accounting and loss control, pricing, and education. In order to be successful, these strategies demand data, which is provided by a wide range of technologies. This data can then help utilities develop programs that improve customer services and reduce water losses.

4.3 Smart Metering in an International Context

On an international level, SWM has not evolved as extensively as smart metering in the energy sector particularly in electricity. Unlike Australia, many international areas have not suffered severely reduced rainfall conditions and therefore do not have water supply issues. Like Australia, the cost of remotely reading water meters remains high in comparison to manual meter reads. With regard to the latter point, this is changing as the smart metering technology becomes less expensive and its benefits are being recognised by water industry.

Internationally, where SWM Programs and trails are being undertaken, these are aiming to capture financial, economic and social benefits. These programs (and trials) are being implemented as water only metering implementations, or as multi-utility combinations of water, electricity and gas metering.

Significant SWM programs are currently underway in Canada, United States of America and Australia (Victoria and ACT). These comprise about 18% of all AMR projects (electricity, water, and gas) worldwide[11].

In the United States, the adoption of smart meters by electricity companies to better manage their infrastructure is encouraging the water sector to follow suit in order to deal with their water leakage challenges[12]. According to statistics, well-run water systems can still lose 10% to 15% a year through distribution leaks. The American Water Works Association has cited examples of losses of up to 45% in the water system[13].

4.4 Review of Selected SWM and AMR Projects

Ten projects were reviewed. These projects ranged in the following areas:

- In functionality from AMR to SWM; and
- In size from pilot and trials (500 – 1,500 meters) to full scale mass market deployments (greater than 100,000 meters).

The metering projects reviewed were:

- Wide Bay Water AMR Smart Metering Program, Queensland[14];
- South East Water EcoPioneer Pilot, Victoria[15];
- ActewAGL, Residential Multi-Utility Integrated Metering Infrastructure (MIMI) Project, Canberra[16,17] ;
- Department of Environment Protection, New York City, USA[18];
- Toronto Water, Ontario, Canada[19];
- Detroit Water Automated Meter Reading (AMR) Program[20];
- Chicago Department of Water Management, Illinois, USA[21,22];
- City Of Atlanta Department Of Watershed Management, Georgia, USA[23,24,25];
- Philadelphia Water Department, Pennsylvania, USA[26];
- City of San Marcos, Texas, USA[27,28]; and
- Sydney Water, Australia[29].

A summary of these projects appears in **Attachment I.**

Collectively, the projects highlight the common benefits being sought by SWM and AMR projects, the impact of scale on metering cost and technologies being deployed.

4.4.1 Benefits

The benefits of SWM and AMR were proposed across a range of categories including:

- Identification and reduction of water leakage;
- Improved asset management efficiency and effectiveness;
- Reduced cost of retail operations (although these costs may increase initially due to extensive enquiries and then reduce over time)[30]; and

- Customer benefits through changing consumer water efficiency and consumption attitudes and behaviour.

Table 4 below provides an international comparison of benefits attributed to SWM and AMR. Additional benefits detail is provided in **Attachment II**.

Table 4: SWM and AMR Benefits

Project	Water Leakage		Improved Asset Management and Investment	Reduced Cost of Retail Operations		Customer Benefits			
	Reduced water leakage	Reduced unmetered consumption		Reduced meter reading expense	Back office savings	Behavioural change / Environmental	Enhanced customer satisfaction	Customer usage information	New tariffs enabled
Wide Bay Water, Australia	✓		✓			✓	✓		✓
South East Water, Australia	✓		✓			✓	✓	✓	
ActewAGL, Australia	✓		✓	✓	✓	✓		✓	✓
Department of Environment Protection, New York City, USA	✓		✓		✓	✓	✓	✓	
Toronto Water, Canada		✓	✓	✓					✓
Detroit Water, USA				✓	✓				
Chicago Department of Water Management, USA	✓	✓		✓	✓	✓	✓		
City Of Atlanta Department Of Watershed Management, USA	✓	✓		✓	✓			✓	
Philadelphia Water Department, USA		✓		✓	✓		✓	✓	
City of San Marcos, USA	✓	✓	✓	✓	✓	✓		✓	

4.4.2 Costs

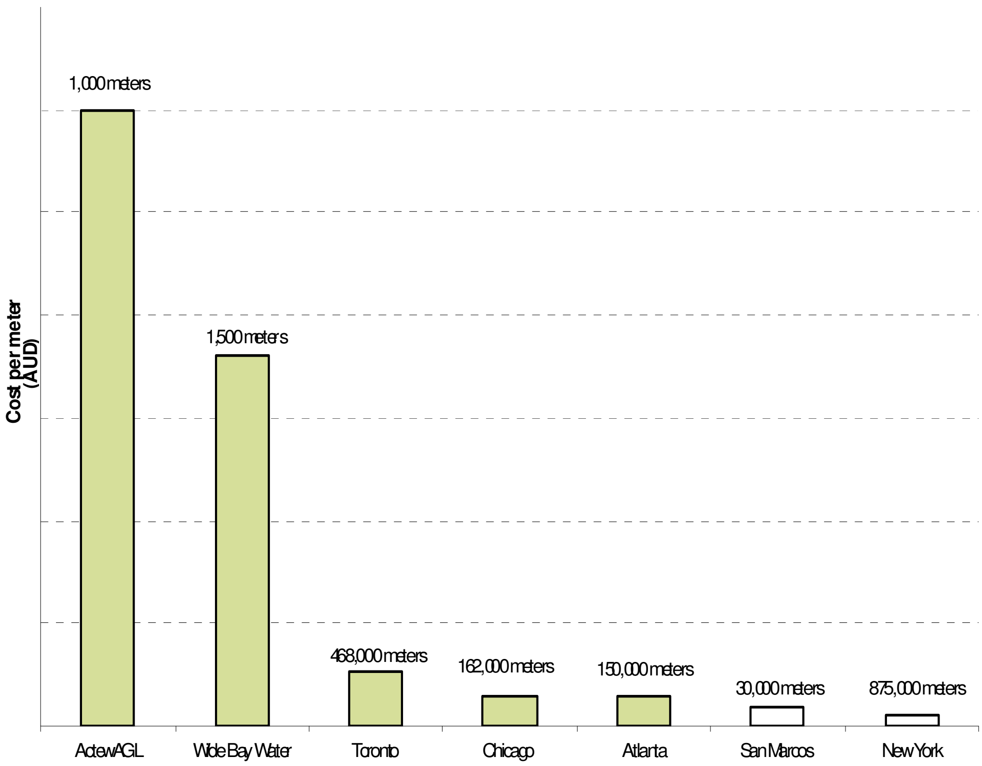
The literature review has highlighted that the major driver in the cost of metering programs is scale.

Additional cost details are provided in **Attachment III**.

Figure 5 below demonstrates the impact of implementation scale on the ultimate cost per meter installed. Small-scale pilots may help quantify some of the purported benefits of SWM and AMR, but they do not offer the same economy of scale as a large city-wide rollout.

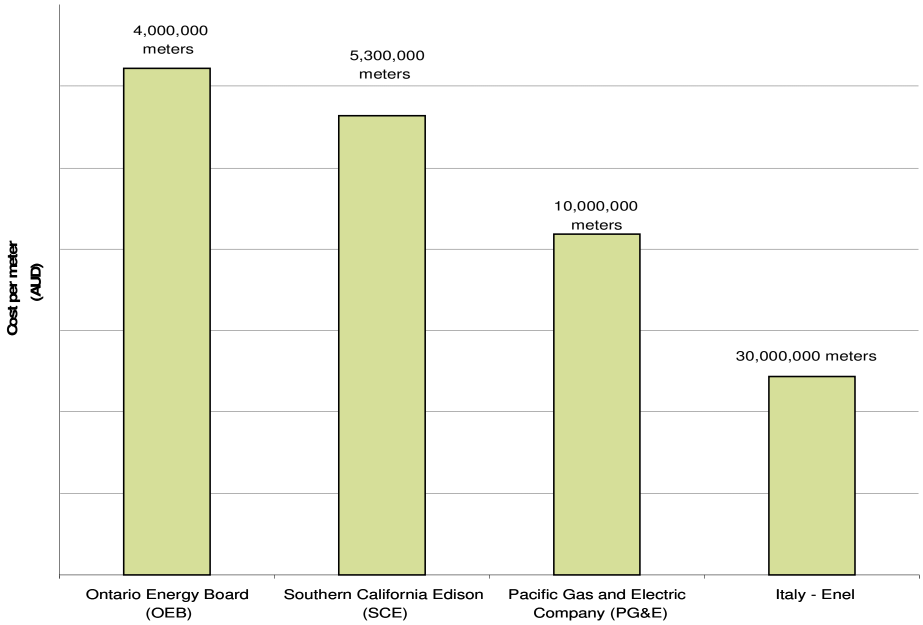
The functional sophistication of the meters selected in each program appears to have a lesser, but still significant, impact on costs on a per-meter basis. There are, of course, peculiarities of geography, climate and politics that will affect the cost of any program. In Toronto, for instance, the need for water meters to be housed indoors to avoid being impacted by climatic conditions (and therefore, being less accessible to mobile installers) contributes to the high cost of rolling out that city's AMR program.

Figure 5: SWM and AMR Costs



The same trend is demonstrated in Smart Electricity Metering programs (refer Figure below), with scale often mitigating the fixed investment costs in IT systems or program management.

Figure 6: Smart Electricity Metering Costs [31] [32] [33] [34]



4.4.3 Functionality

A range of metering and communications technologies were employed in the SWM and AMR projects reviewed. The selection of metering and communication technology appears to have been driven by local regulatory or environmental conditions (e.g. accumulation versus pulse versus interval data, SWM versus AMR, indoor versus outdoor meter installations, single versus multi utility, etc).

Victoria's smart metering communications architecture is anticipated to include a ZigBee enabled Home Area Network. This type of communications architecture was not observed in the projects reviewed, which appeared to be based on proprietary communications rather than open protocols. However, Gothenburg Sweden[35] have implemented ZigBee for their 265,000 electrical AMI meters and are considering the trialling of SWM.

In Europe however, a mandate has been established to create European Standards for the development of open utility meter communications architecture. This has involved establishing protocols that enable interoperability of meters, so allowing for multi-utility smart metering[36].

Open protocols and standards will allow for the development of open source software that is accessible to the public via the internet. For example, Google has developed a software tool called "Google PowerMeter" which will allow consumers to view their consumption information almost real time[37]. Google are currently working with utilities to rollout the software through pilots.

Attachment IV provides a summary of technology and functionality by project.

5 Conclusions

5.1 Water Demand

Water has historically been cheap in Australia, both in absolute terms and as a proportion of household income. The price of water in Australia is infrequently changed, and does not rise and fall to reflect its scarcity.

In times of water shortage governments have opted to use water restrictions, rather than price, to balance supply and demand because use of the economically efficient price of water has not always been politically feasible. These restrictions, though, were never intended as long term measures and their current permanency is the result of a reduction in rainfall of unforeseen severity and the long lead times to develop new sources of supply. ABARE and the NWC argue that restrictions have become a relatively inefficient method of demand management, as they drive inconvenience costs, efficiency losses and a requirement for substantial enforcement effort.

An alternative option is to adopt scarcity pricing based on dam levels, but this is considered by some in the water industry to be ineffective due to the infrequency of billing and subsequent latency in consumer pricing signals, the consumer's lack of knowledge of the price of water consumed at any given point in time, and its possible impact on lower socio-economic consumer groups. Conversely, the NWC does support further investigation in scarcity pricing in urban areas on the basis that it will be more effective in balancing supply and demand.

The limited price and income elasticity data that is available indicates that water is an inelastic good (e.g. when the price of water increases by 100% demand for water could drop by 30-40%, and when income doubles water demand will increase by 20-25%). It is also thought that elasticity may differ between water used for indoor and for outdoor use, and it is unclear how elasticity, or the effect of price on demand, might change as the price becomes significantly higher (or lower).

The willingness to pay for smart water meters is difficult to assess directly, as there is little existing literature available, and willingness to pay is dependent on time, geography, functionality of the specific meter on offer, and the values and priorities of the community who are being asked to pay for it. As a proxy, investigations have shown that customers are willing to pay several hundreds of dollars, even thousands, for alternative water sources via rainwater tank packages and recycled water cartage.

This review has shown that the water industry's knowledge of scarcity pricing, price and income elasticity, willingness to pay and the influence of SWM in these areas are incomplete and inconclusive.

5.2 SWM and AMR Projects

The Australian and International Water AMR programs investigated in this review align with a likely set of primary water policy objectives that are applicable in Victoria. In each case, the programs studied found that leakage and tampering detection, network demand and asset management, water conservation, and customer interfaces (e.g. billing) can all (in varying degrees) be improved by AMR. The Gothenburg, Sweden study has identified that there are quantifiable benefits through leakage management and customer empowerment, however, these needs to be validated through SWM trials. Gothenburg, Sweden is currently in discussions with their local water authority to trial SWM.

Despite the work being done by Gothenburg, the potential applications of SWM, as defined in Section 4 (water usage analytics and alerts, customer education, two-way communication) are not widely discussed. It is unclear how successful these would be if presented to customers in a real-world implementation, and there are few precedents from either the electricity or water industries to guide this Study.

Attachment I: SWM and AMR Project Descriptions

Wide Bay Water AMR Smart Metering Program, Queensland, Australia	The Wide Bay Water AMR Smart Metering Program involved a replacement of 20,000 water meters with AMR meters. The implementation was completed in September 2007. A pilot trial was conducted with the initial rollout of 1500 AMR meters.
South East Water EcoPioneer Pilot , Victoria, Australia	South East Water, Landis+Gyr, AGL and Alinta Asset Management established the EcoPioneer Pilot project in March 2007 aimed at reducing water, electricity, gas consumption and greenhouse gas emissions. The pilot involved 50 households using smart ecoMeters over a 12 month to measure and benchmark usage. The device also tracks improvements, and allows households to compare their daily, weekly and monthly utility usage.
ActewAGL, Residential Multi-Utility Integrated Metering Infrastructure (MIMI) Project, Canberra, Australia	The Government of the Australian Capital Territory is about to commence a SWM trial with ACTEW and AGL to measure the changes in water consumption and community attitudes. If the trial is successful, a citywide program will be designed, costs established, and cost recovery options identified.
Department of Environment Protection, New York City, USA	The City of New York's Department of Environmental Protection developed a "Citywide Advanced Metering Infrastructure Program". The City aims to automate its meter reading capabilities and improve customer service for the eight million customers on its metered water distribution network.
Toronto Water, Ontario, Canada	In May 2008, Toronto Water committed to rolling out wireless-enabled water meters. Toronto Water had considered "piggybacking" the electrical smart meter installation project launched by Toronto Hydro however, however, it was determined not possible because water meters are inside the home at the basement level (due to extreme cold weather in Winter).
Detroit Water Automated Meter Reading (AMR) Program, USA	The Detroit Water and Sewerage Department (DWSD) plans to install or retrofit every residence in Detroit with new meter reading technology, thus eliminating estimated water bills. Meter installations began in December 2007 and will continue for three years until all 275,000 Detroit residences and 3,000 businesses are equipped with new meter equipment. Six phases have been completed so far, and phase six began in Nov. 2008. About 160,000 of DWSD's customers will require new water meters. As part of DWSD's ongoing maintenance program, it has installed approximately 115,000 new meters in homes since 1996. These meters can be retrofitted as part of the Detroit Water AMR program.
Chicago Department of Water Management, Illinois, USA	The Chicago Department of Water Management has a long-term initiative to manage its water resources. Smart metering was identified as beneficial in achieving this outcome. The City of Chicago has contracted with Badger Meter to automate the city's meter reading process using the company's radio read system. Once implemented, broadcasted data from each meter's transmitter can be collected by Chicago's Department of Water Management employees driving down the streets on a monthly basis. The estimated cost on lost revenue over 3 years exceeded the cost of replacing all meters. In addition, the Chicago Department of Water Management aims for universal metering. Having a reliable AMR system in place is an essential foundation for universal metering.
City Of Atlanta Department Of Watershed Management, Georgia, USA	Atlanta's AMR project is a part of the city's $3.9 billion Clean Water Atlanta infrastructure improvement program to overhaul the City's water and wastewater systems and create an efficient and cost-effective utility, providing clean, safe water to residents and downstream neighbours. The key drivers for the Department of Watershed Management (DWM) to implement smart metering were a long and arduous billing cycle, safety of meter readers, and lack of meter accessibility.

Philadelphia Water Department, Pennsylvania, USA	The Philadelphia Water Department and Water Revenue Bureau (PWD) is a municipal public utility that provides water, wastewater and storm water services to more than 2 million people in the City of Philadelphia and surrounding area. PWD implemented its AMR program to serve its customers more effectively while reducing costs and improving operational efficiency by monitoring and measuring the performance of the entire water distribution network. Chronic meter access difficulties, coupled with a quarterly reading schedule designed to limit high manual meter reading costs, meant that nine out of 10 of the department's monthly bills were based on estimates. More than 100,000 customers out of a total customer base of less than a half million had not had their meter read for more than a year. Citizens in the Philadelphia area had also been targeted by several scams in which con artists presented themselves as utility workers to gain entry to homes.
City of San Marcos, Texas, USA	San Marcos City Council has approved the installation of a $4.8 million smart electricity and water metering system for all 30,000 residents/businesses supplied by the city's electricity and public water utilities. The system will read meters electronically, improve the accuracy of billing and allow customers to keep track of their water and electricity use during the month via the internet. The utility will be able to notify customers of unusual consumption usually caused by leaks or other problems. The Smart Metering system will be for both electricity and water, with meters embedded with devices that communicate reads to "gateways" that hold the data until it is transferred to the Utility where it is processed. The smart metering project reflects the City Council's policy commitment to streamline government, make its services more accessible and encourage conservation.
Sydney Water, New South Wales, Australia	Sydney Water has conducted a number of SWM trials. An independent trial was recently conducted on 468 residential properties in the suburb of Westleigh over 16 months. Data was collected in 15 minute intervals and was analysed to establish consumption trends, night usage and leakage calculations. Each customer was fitted with an In-Home Display that displayed: • 24 hour water usage • Monthly water usage • Last week versus this week's usage • Daily usage • Meter reading, and • Leak alarm. Upon completion of the trial, participant surveys were completed and 20 interviews were conducted (results still being processed). Additional to this trial, Sydney Water are participating in Energy Australia's "Smart Village" trial which integrates smart metering for both water and electricity. The trial involves a rollout of 1000 meters. Meters are expected to be deployed in July 2009 and Home Area Networks with In-home displays installed in 2009/2010.
East Bay Municipal Utility District	EBMUD has been conducting a 10-year pilot study using automated meter reading (AMR) technology to encourage water conservation. The study is designed to measure end-use demand, quantify savings from water efficient products and practices, and help identify and locate potential water loss from leaks in the distribution system or customer side of the meter. The information will help staff customers to better understand water use and opportunities to conserve water and save money. The new pilot will serve potable water to approximately 4,000 customers in the area of Blackhawk (Danville). The AMR system provides customers access to their hourly water consumption data through a website and alerts customers to possible leaks in their home plumbing. In January 2007, EBMUD prepared a business case for the implementation of Advanced Metering Systems (AMS). The business case concluded that AMS offers a financially sound alternative to the current meter reading program at EBMUD.

Attachment II: SWM and AMR Benefits

Project	Water Leakage		Improved Asset Management and Investment	Reduced Cost of Retail Operations		Customer Benefits			
	Reduce water leakage	Reduce unmetered consumption		Reduced meter reading expense	Back office savings	Behavioural Change / Environmental	Enhanced customer satisfaction	Customer usage information	New tariffs enabled
Wide Bay Water, Australia	Yes: 182ML/a		Yes			Yes: 914ML/a	Yes		Yes: ToU
South East Water, Australia	Yes		Yes			Yes: 11% reduction in water use	Yes	Yes	
ActewAGL, Australia	Yes		Yes	Yes	Yes	Yes		Yes	Yes (Various proposed)
Department of Environment Protection, New York City, USA	Yes		Yes		Yes	Yes	Yes	Yes	
Toronto Water, Canada		Yes: $28.0m/a	Yes	Yes: $5.0m/a					Yes: ToU, CPP, Load shedding

Project	Water Leakage		Improved Asset Management and Investment	Reduced Cost of Retail Operations		Customer Benefits			
	Reduce water leakage	Reduce unmetered consumption		Reduced meter reading expense	Back office savings	Behavioural Change / Environmental	Enhanced customer satisfaction	Customer usage information	New tariffs enabled
Detroit Water, USA				Yes	Yes				
Chicago Department of Water Management, USA	Yes	Yes		Yes	Yes	Yes	Yes		
City Of Atlanta Department Of Watershed Management, USA	Yes	Yes		Yes	Yes			Yes	
Philadelphia Water Department, USA		Yes		Yes: $2.75m/a	Yes		Yes: 20% reduction in call volume	Yes	
City of San Marcos, USA	Yes	Yes	Yes	Yes	Yes	Yes		Yes	

Table Notes

Philadelphia Water Department, USA

Philadelphia expects AMR to achieve cumulative financial benefits of $25 million over the 20-year useful life of the system, derived from an increase in actual meter readings, more accurate bills, reduced customer calls and complaints concerning their bills, and a significant reduction in meter reading costs. The annual $2.75m benefit in the table will in fact cover multiple benefit streams, however we do not have an exact breakdown of the benefit sources.

Attachment III: SWM and AMR Costs

Project	Commencement Date	Pilot – Number of Meters	Pilot - Duration		Full Roll Out – Number of Meters		Full Roll Out - Duration
Wide Bay Water, Australia	September 2006	1,500	12 months		22,000		
South East Water, Australia	2007	50	12 months				
ActewAGL, Australia	March 2008	1,000	18 months				
Department of Environment Protection, New York City, USA	July 2008	200	Developed into full roll out		875,000		3 years
Toronto Water, Canada	2009				468,000		6 years
Detroit Water, USA	December 2007				278,000		3 years
Chicago Department of Water Management, USA	2008				162,000		3 years

Project	Commencement Date	Pilot – Number of Meters	Pilot - Duration		Full Roll Out – Number of Meters		Full Roll Out - Duration
City Of Atlanta Department Of Watershed Management, USA	December 2006	493 (airport & large commercial)	Developed into full roll out		150,000		3 years
Philadelphia Water Department, USA	September 1997				472,000		12 years
City of San Marcos, USA	April 2009	500	~12 months		30,000		

Table Notes

ActewAGL, Australia
The pilot duration is expected to comprise:
- Stage 1 – Project design – 3 months
- Stage 2 – Procurement and initial installation – 2 months
- Stage 3 – Refinement and full trial implementation – 12 months
- Stage 4 – Evaluation and review – 2 months

Attachment IV: SWM and AMR Functionality

Project	Meter Supplier	Recording Interval	Electricity AMI Interface	Communication	Utility Systems Interface	Real Time Alerts	Customer Account Self-Service
Wide Bay Water, Australia	Elster	60 min		Radio transmission to mobile readers	Manual processing – data conversion system under development		Yes
South East Water, Australia	AMPY Email Metering	1 min (max. meter capability)	Radio communication from water meter to single AMI interface			Yes: Network load	Yes
ActewAGL, Australia	TBD	60 min (proposed)	Radio communication from water meter to single AMI interface	TBD	Database and software reconfiguration		
Department of Environment Protection, New York City, USA	ESCO Technologies			2.5Ghz wireless network			Yes
Toronto Water, Canada	Elster	60 min	Standalone	450-470 MHz wireless network (via neighbourhood collection point)			

Project	Meter Supplier	Recording Interval	Electricity AMI Interface	Communication	Utility Systems Interface	Real Time Alerts	Customer Account Self-Service
Detroit Water, USA	Itron Inc	4 hours	Standalone	Transmitter connected to water meter; neighbourhood antennas transmit to Detroit Water			
Chicago Department of Water Management, USA	Badger	60 min		Radio transmission to mobile readers			Yes
City Of Atlanta Department Of Watershed Management, USA	Neptune		Standalone	Radio transmission to mobile readers			
Philadelphia Water Department, USA	Itron Inc			Radio transmission to mobile readers			
City of San Marcos, USA	EKA Systems	30 minutes	Radio communication from water meter to single AMI interface	Wireless network		Yes: Battery condition and tampering	Yes

Table Notes

Wide Bay Water, Australia

The Wide Bay Water AMR Smart Metering Program uses a standard ELSTER meter and DATAMATIC data logger called a “Firefly” which records hourly flow of up to 330 days and a DATAMATIC transceiver called a “Road Runner”.

Once the Road Runner captures the data, it can be transferred to a desktop where the data is processed for billing. Wide Bay Water is currently developing a package to compile and convert raw data into friendly water consumption data.

Department of Environment Protection, New York City, USA

Water meter modules utilise Aclara’s STAR Network System to collect interval data for billing and to support other programs that are designed to allow the customers to better manage water consumption, identify leaks and equipment problems and effectively control other operating costs.

A 2.5 GHz wireless network spaning 494km in area across New York City is currently being installed.

Chicago Department of Water Management, USA

The rollout only applies to properties that are already metered.

City of Atlanta, USA

System permits the electronic collection and transmission of customer water usage data from water meters to the billing office through the use of both fixed radio and mobile radio methods.

Philadelphia Water Department, USA

A single person, driving a DataCommand Unit, is capable of reading up to 20,000 meters a day.

References

[1] Grafton Q, Determinants of Residential Water Demand in OECD Countries

[2] Melbourne Water, History of drought in and around Melbourne

[3] Our Water Our Future: The next stage of the Government's water plan, 2007

[4] IPART, Water scarcity: Does it exist and can price help solve the problem?, 2008

[5] National Water Commission 2 July 2008

[6] J.F. Thomas and G.J. Syme, 1988, Estimating residential price elasticity of demand for water: A contingent valuation approach, Water Resources Research

[7] Cave Review: competition and innovation in water markets, http://www.defra.gov.uk

[8] P. Perry, 2009, DRAFT Smart Water Metering Requirements

[9] Newton Wayman Chong & Associates, 2001, System Security Standards Study Group: Customers Value Study – Quantitative Stage – A Research Report

[10] Department of Sustainability and Environment, 2008, Project Descriptions

[11] Analysis of Smart Metering projects collated by the UK Energy Retail Association, Smart Metering Projects Map, Google maps

[12] Metering.com, 2008, North American water industry faces challenging future

[13] Water Utility Management – Acquiring Good Data to Improve Water Utility Services, January 2009, Laura Wainwright, Aclara

[14] Wide Bay Water Corporation, Innovative Smart Metering Program for Hervey Bay Fact Sheet

[15] B. Wetherall, South East Water, Draft Report of the Eco-Pioneer Pilot Program

[16] Halcrow Pacific Pty Ltd, 2008, Independent Competition and Regulatory Commission Review of Capital and Operating Expenditure associated with ACT Water Security Measures

[17] Anita Del Gigante, 2007, Project MIMI (Multi-Utility Integrated Metering Infrastructure) Electricity, Gas and Water Smart Metering

[18] Patricia K Moore, ESCO Technologies,2008, Media Release ESCO announces $68.3 million New York water AMI contract

[19]Smartmeters.com, 2008, Toronto set to install smart water meters

[20] Detroit Water, Detroit Water Automated Meter Reading (AMR) Program Frequently Asked Questions

[21] WaterWorld, 2008, Chicago Plans Radio Read AMR System

[22] Water Online, 2007, Case Study: Chicago Saves Nearly $1/2 Million in Annual Revenue

[23] City of Atlanta, Department of Watershed Management, ATTOREAD Automated Meter Reading Project Frequently Asked Questions

[24] City of Atlanta, Department of Watershed Management, Automated Meter Reading Project Facts

[25] The City of Atlanta, Department of Watershed Management, Case Study: From High-Maintenance to Hybrid: Atlanta Discovers the Benefits of AMR

[26] Michael Nadol, James Bolno and Michael Hogan, Philadelphia Water Department, AMRA News, Philadelphia's Aggressive Deployment Schedule Yields 25,000 Installations a Month

[27] Melissa Millecam, Communications Director, City of San Marcos, 2008, San Marcos to Install 'Smart Meters'

[28] City of San Marcos, 2008, City Council Project Briefing Forms October 2008

[29] Note: Sydney Water's smart metering trial has not been included in the analysis of costs and benefits however a summary of the trial is provided.

[30] R. Lamoreaux, D. I. Wallace, DRAFT Advanced Metering Systems, The Business Case for EBMUD, 2007

[31] Ontario Energy Board, *www.oeb.gov.on.ca/*

[32] Southern California Edison, *www.sce.com/Feature/Archive/smartconnect*

[33] Pacific Gas and Electric, *www.pge.com/smartmeter*

[34] Enel, *www.mce.gov.au/assets/documents/mceinternet/SmartMetersInfoPaper20070123163300.pdf*

[35] Tomas Arnewid, Goteburg Sweden, Email correspondence, 22/5/09

[36] European Commission, Enterprise and Industry Directorate General, New Approach Industries, Tourism and CSR, Standardisation, 2008. Doc. 83/2008, Standards and Technical Regulations" 98/34 C

[37] The Official Google.org blog, 2009, Power to the People