

ENHANCING THE SMART METERING BUSINESS CASE WITH WATER

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ABSTRACT

While the business case for smart metering within the electricity sector typically relies upon both operational and societal benefits to establish a positive case; the operational benefits of smart metering for Water Authorities are sufficient in their own right to establish a business case.

Given that there are major Smart Electricity Metering programs underway in Europe, North America and Asia-Pacific, it is surprising that, to date, limited cross utility metering has been investigated or proposed.

In Australia, considerable interest in Smart Water Metering has been driven by drought, rising water cost, and the potential to leverage the communications infrastructure being established for Smart Electricity Metering.

Marchment Hill Consulting was appointed in early 2009 by the Victorian Department of Sustainability and Environment to study the potential costs and benefits of implementing smart metering in the Victorian Urban Water Sector. This paper describes key findings of that Study and outlines potential impacts on electricity utilities from sharing their smart metering communications infrastructure.

1. INTRODUCTION

Australian water supply issues, driven largely by drought, create the need to provide water consumption data in a form and at a frequency that allows for improved investment decisions by water authorities, and increased customer engagement in managing their water consumption.

The energy sector has had some success in using Smart Electricity Metering (SEM) to change customer behaviour through increased awareness, and has benefited the industry via more efficient investment in generation and network augmentation. These benefits might translate to the water industry.

A survey of Australian consumers¹ 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 survey showed that 42% of individuals cannot 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. By providing consumer education it may be possible to establish a generational and societal change in attitudes towards water efficiency and consumption.

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

Internationally, Smart Water Metering (SWM) has not evolved as extensively as SEM in the energy sector. Unlike Australia, developed countries which are progressing SEM have not generally suffered severe drought, and the cost of remotely reading water meters in isolation remains high in comparison to manual reading. However, smart metering technology is becoming less expensive, and its benefits are being recognised by the water industry. The potential to leverage smart metering infrastructure across more than one utility is also making its potential application for an individual utility more economically viable.

Where SWM programs are being undertaken, these are aiming to capture financial, economic and social benefits. These programs are either water-only metering implementations, or multi-utility implementations, combining electricity metering with either water or gas metering. There are very few, if any, implementations that combine all three.

The state of Victoria (Australia) has mandated the deployment of SEM and one would expect that leveraging the existing SEM network would lower the costs for a SWM implementation.

This paper describes key findings of the Study conducted by the Victorian Department of Sustainability and Environment and outlines some of the costs and benefits of leveraging the existing SEM network.

2. PROBLEM FORMULATION

The Department of Sustainability and Environment undertook a Study to investigate the potential costs and benefits of implementing 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 utilities across the world in smart metering;
- The need to significantly improve delivery of potable water and associated services, and enhance other water efficiency initiatives
- Empowering customers to better manage consumption and providing valuable demand information to water sector stakeholders;
- The need to stimulate innovation in water management and the achievement of long term Victorian water industry reform objectives; and
- An opportunity for the water industry to leverage Victoria's investment in SEM.

The SWM Cost Benefit Study recognises the environment in which the urban water sector across Victoria operates, considers the relevance of smart metering to a future Victorian Urban Water Sector, and analyses the quantitative and qualitative costs and benefits of SWM to determine the net benefit.

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

2.1. 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 period of decreased rainfall and changes in its patterns, significantly diminishing reservoir storage levels;
- Extended, severe water restrictions imposed as the primary tool to manage supply shortages;
- Debate on the effectiveness of current tariff pricing regimes at driving efficient water use;
- Increased scrutiny on bulk water planning, water restriction policies and the price of water.

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

2.2. The Victorian Electricity AMI Program

Studies by the Victorian and Federal Governments have found potential net benefits from implementing SEM to approximately ten million electricity customers across Australia.

The Victorian Government mandated the deployment of SEM 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 AMI program has been established to deliver on these mandates.

These meters include functionality supporting a Home Area Network which connects devices on customers' premises, and allows communications between these devices and the electricity distributor.

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

2.3. SWM Definitions

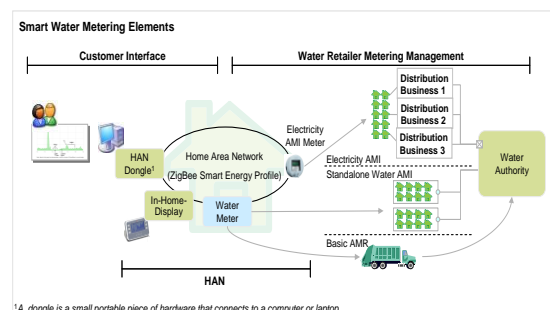
Driven by electricity investment, metering in the past decade has evolved from interval meters with simple communications, to advanced or smart metering with an increased range of metering and communication functionality.

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

- Recording of water consumption within a day;
- Remote meter reads, scheduled and on-demand;
- Notification of abnormal water usage;
- Control of water-consuming devices within a customer's premise; and
- Messaging to the customer.

The diagram below depicts the high level relationships between customers, the household (or metered site), and Water Authorities.

Figure 1: SWM Logical Architecture



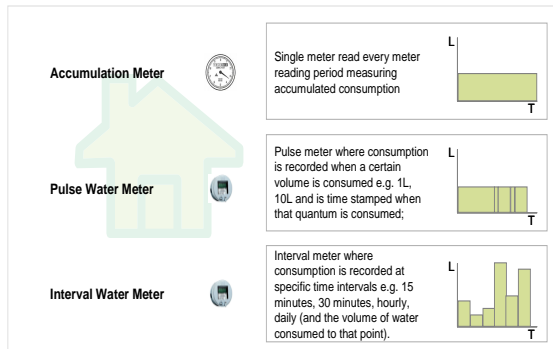
To date, water meters have been Accumulation meters, yielding a single value per read. SWM could record consumption data in two ways, either:

- Pulse: 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: a metered consumption data point is recorded at specific time intervals e.g. 15

minutes, 30 minutes, hourly, daily (and the volume of water consumed to that point).

The differences in Accumulation, Pulse and Interval data collection are depicted below.

Figure 2: Types of Metering



3. APPROACH

Marchmont Hill Consulting performed both a quantitative and qualitative analysis of the potential costs and benefits of Smart Watering Metering.

This paper provides details of the quantitative study that was performed and demonstrates that the operational benefits alone provide a compelling argument for Water Authorities in Victoria to proceed with SWM. The paper also discusses some of the findings of the qualitative study that was performed and the relevance of these to the implementation of SWM.

Information for this study was gathered through consultation and interaction with the Victorian Water Authorities and a Literature Review which investigated international SWM initiatives.

4. RESULTS

4.1. SWM Implementation Options

The Victorian electricity industry has decided on time-based measurement of consumption, or interval metering. This decision is based on historical practices in remote metering of electricity consumption, and for 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 on a ½ hourly tariff basis. Therefore, measurement of customer energy consumption on a ½ hourly basis will facilitate wholesale market trading activities; and
- Electricity infrastructure is constrained, particularly during periods of extreme heat. Half hour consumption data allows the grid manager

to balance supply and demand during these critical peak periods.

Options for the implementation of SWM arise through choices on:

- Water Authority communications: The method and frequency of data collection; 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.

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

Implementation Option 1: Weekly AMR services.

This approach uses drive-by data collection technology, and accumulation meter reads from AMR-enabled meters. Data is collected on a weekly basis. Meters are read using RF or similar technology. A data collection device is attached to a vehicle which drives past each AMR-capable meter. This is commonly called a 'garbage truck scenario', as these trucks travel the routes likely to be required for meter reading on a regular weekly schedule. Only accumulation meter reads are collected (similar to what is currently collected today). This reduces the costs associated with storage of data, before and after collection.

Implementation Option 2: Weekly pulse meter data collection.

This approach uses drive-by data collection technology and pulse meter reads from AMR enabled meters. 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 this quantity of water is consumed. A data logger connected to the meter records the date and time of each pulse generated by the meter.

As with Implementation Option 1, a data collection device is attached to a vehicle which drives past each AMR-capable meter. Collection of weekly pulse meter reads can approximate time-of-use metering through mapping the time-stamp of each pulse into discrete time intervals.

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, the customer could view unvalidated metering data directly from their meter, and use this data to make informed choices concerning their water usage.

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).

Under an Order-in-Council, the Victorian Electricity Distribution Businesses are required to install an AMI communications network and SEMs for all small electricity customers (both residential and commercial) in Victoria. The SEMs contain ZigBee™ communications which potentially allow connection to other ZigBee™ enabled devices, including water meters. This approach assumes that commercial agreements between Water Authorities and Electricity Distribution Businesses allow Water Authorities to access the Electricity AMI communications network so as to collect water meter data and send messages to their customers.

Using this communications network, collection of pulse meter data can occur as often as every day. Water Authorities would be required to pay an AMI network access fee to the Electricity Distribution Businesses to use this service (the determination of the magnitude of the network access fee is outside the scope of this Study).

Collection of metering data will require each Water Authority to build an interface to at least one Electricity Distribution Business. As an alternative option, creation of a new water meter data management business that can collect metering data from the Electricity Distribution Businesses on behalf of the Water Authorities could be considered (the cost benefit impacts of this alternative option have not been considered within this Study).

Under this Implementation Option, the Water Authority can 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 unvalidated metering data from their water meter via the electricity AMI meter to make informed choices concerning their water usage.

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 such as 30 minutes, 1 hour or daily. Using ZigBee™

communication and the Electricity Distribution Businesses AMI communications network, collection of interval meter data can occur as often as every day. Like Implementation Option 4, this approach assumes that commercial agreements between Water Authorities and Electricity Distribution Businesses allow Water Authorities to access the Electricity AMI communications network so as to collect water meter data and send messages to their customers.

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.

As per Implementation Option 4, collection of metering data will require each Water Authority to build an interface to at least one Electricity Distribution Business for collection of meter data.

Under this Implementation Option, the Water Authority can send communications to customers, and customers can display unvalidated metering data to make usage decisions.

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 Water Authorities. Water AMI networks could be built by individual Water Authorities and operate independently of all other AMI networks; alternatively, a shared approach to construction of a water AMI network involving all Water Authorities could be considered. The cost of construction does not significantly differ between these Implementation Options.

The water AMI communications network will consist of a 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 depends 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.

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

Under this Implementation Option, the Water Authority can send communications to customers; and customers can display unvalidated metering data to make usage decisions.

4.2. Quantitative Results

The SWM Cost Benefit Study considered key benefit and cost elements including: Meter procurement, installation and maintenance; IT systems; Meter reading and communications; Customer service; and Asset management.

The quantitative analysis performed in this study assessed the change in the benefit and cost elements, when compared to a ‘Do Nothing’ scenario.

Assumptions. A large number of assumptions were made in developing the model. Certain assumptions that serve as input variables to the cost benefit analysis have a particularly strong effect on the result of the analysis. These include:

- Cost of procuring meters;
- Cost of scheduled and special meter reads;
- Cost of IT system integration;
- Projected increase in water prices;
- Reduction in network leakage; and
- Improvement in capital efficiency.

Analysis. With increasingly complex Implementation Options come increasing upfront costs and a lengthening period before positive annual net benefits are realised. All of the Implementation Options selected eventually show positive annual net benefits by Year 9 at worst, or near the completion of the first SWM roll-out.

Annual Net Benefits. In Implementation Options 1 to 4, positive annual net benefits appear by Years 5 or 6, and the ongoing net benefits from a mature rollout (at Year 30) are broadly similar at \$25m - \$29m per year.

In Implementation Options 5 and 6, the positive annual net benefits take longer to offset the heavier costs of interval metering and AMI capability – by Years 8 and 9, respectively.



The relative NPV for Implementation Options 1 – 6 is shown below. The cost of meters (including communications infrastructure), along with the cost of IT systems to support them, increases in steps with:

- Transition from accumulation meters to pulse meters, and then to interval meters; and
- Transition from “drive by” meter data collection to use of the electricity AMI network (Option 4 and 5), and then to a standalone AMI communications network for water (Option 6).

NPV – Base Case. The benefits derived from reduced meter reading costs are greatest if an AMI network is used (Implementation Options 4 - 6). The benefits from improved asset management (including leakage detection and improved leak management) are roughly constant for all pulse or interval data Implementation Options.

Figure 3: Indicative NPV Outcomes

Implementation Option	NPV
1 Weekly Basic AMR Services	+
2 Weekly Pulse Meter Data AMR Services	+
3 Weekly Pulse Meter Data AMR Services plus In House Communications	+
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	-

 NPV > 0
 NPV < 0

The key findings of the quantitative analysis were:

- NPV positive outcomes can be demonstrated for Implementation Options 1 – 4
- Collection of interval metering data via Implementation Options 5 and 6 is NPV negative – the meters and associated systems are more expensive and the information is no more valuable than the pulse information;
- Variations of up to 30% in the cost elements were examined in a sensitivity analysis. These variations do not significantly impact any base case NPV results; and
- Variations in the price of water, rate of reduction in network and household leakage and degree of improvement in capital efficiency were also examined. In extreme cases these variations can drive negative NPV results for Implementation Options 2 – 4.

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

4.3. Qualitative Results

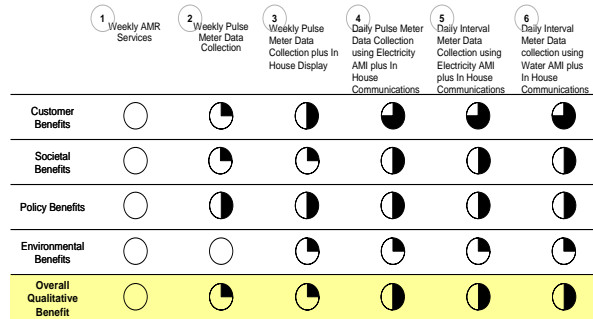
The most significant qualitative customer impact comes through enabling SWM customers to make informed, proactive decisions about using water, in particular through the ability to track water consumption against mandated targets.

The second most significant impact is in allowing customers to identify and rectify household leakages sooner than is possible with accumulation metering.

SWM may also provide additional customer and/or Water Authority benefits through innovative water retail tariffs, support for more frequent customer billing, or enhancing customer relationship management; however, the benefits in these areas were small in the current water sector environment.

The above customer impacts applied in Implementation Options 2 – 6, where the availability of more frequent pulse or interval data would allow customers to monitor their water usage and diagnose leaks. Providing information daily to the Water Authority was also considered to improve benefits compared to a weekly basis. Accordingly, benefits increased progressively between Implementation Options 2 and 4 and then remained the same for Implementation Options 5 and 6.

Figure 4: Summary of Qualitative Analysis



5. DISCUSSION

On the strengths of the quantitative analysis alone, all Water Authorities in the Victorian Urban Water Sector should, as a minimum be considering the deployment of AMR Services (Implementation Option 1). However, as demonstrated by the qualitative analysis, this would provide minimal customer, societal, environmental and policy benefits in comparison to SWM 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 SWM options involving the deployment of interval meters (Implementation Options 5 and 6) are warranted because the additional metering and IT system costs provide no additional qualitative benefit over pulse metering based SWM.

Each of the SWM options involving pulse metering (Implementation Options 2, 3 and 4) warrant further detailed consideration by the Victorian Urban Water Sector businesses: the NPV for each was positive in each case, and supported by qualitative benefits. Further, the sensitivity analysis for each Implementation Option has demonstrated robust NPV values through variation of a range of input assumptions with respect to:

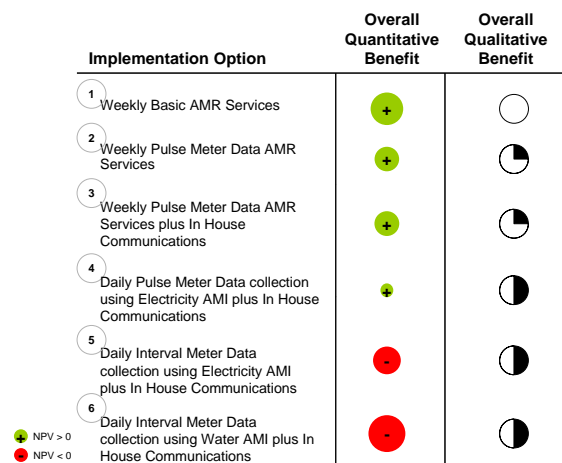
- the cost of procuring meters, scheduled and special meter reads, and IT systems; and
- the price of water, the rate of reduction in network and household leakage, and the degree of improvement in capital efficiency.

Given that the quantitative analysis was based on extrapolating the current sector environment over 30 years, and specifically excluded consideration of a

water market, if further investigation of these Implementation Options demonstrates a positive business case for SWM, then any consideration of benefits and costs of the implementation of a water market does not have to include SWM's costs.

Provided that any further analysis of the likely costs and benefits of Implementation Options 2, 3 and 4 continues to demonstrate a positive NPV, 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 SWM.

Figure 5: Summary of Analysis



6. CONCLUSIONS

This study demonstrated that there is a clear case, on the basis of operational costs and benefits alone, for the Victorian Urban Water Sector to implement SWM. However, more information is required to ensure that any implementation delivers optimal benefits for customer, societal, environmental and policy consideration. This will help quantify the qualitative impacts we considered, so as to better define relative net benefits that could be achieved from each implementation options.

Marchmont Hill Consulting continues to take an interest in SWM and planning of the next steps.

7. REFERENCES

- ¹ Newton Wayman Chong & Associates, 2001, System Security Standards Study Group: Customers Value Study – Quantitative Stage – A Research Report