SMART WATER METERING - OPTIMISING YOUR RETURN ON INVESTMENT

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ABSTRACT

This paper will assist those currently developing their smart metering projects, or considering seeking funding in the future, by helping inform their project scope and to develop a procurement model that is well matched.

There are currently no holistic standards, policies or guidelines in New Zealand providing baseline information to assist those involved in scoping and managing smart water metering projects. With significant investment in the order of tens of millions now specifically targeted at the smart water meter space through early adopters and Tranche One Government funding, its' prudent use is essential to ensure intergenerational benefits and maximum return on investment.

The rapid development of Internet of Things (IoT) connectivity and enabled devices has added an additional and apparently low-cost option for automated water meter reading "AMR" for both commercial and domestic applications. It has also opened something of a Pandora's box in terms of using this platform to capture additional connection and network information to support intelligent management of water systems.

Experience gained through smart metering projects has revealed a wide range of functionality that can be 'stacked' over and above base meter reading and meter status data. An overview of the layers of functionality that can be 'stacked' over and above base meter data capture and transmittal is provided. Assessment of the costs of stacking various types functionality, the value/benefit delivered, the degree of complexity and risk that comes with increased scope, and options for procuring and delivering the project are provided.

With multiple smart meter, plug-in IoT device, communication, software and 3rd party plug-in portal providers active in the market the potential scope of smart metering projects is wide and varied, with all parties espousing the benefits of their solutions. A further complication is a high degree of overlap between device, communication and analytics and insight providers.

There is also an understandable tendency for clients to add functionality to the project scope (the nice to have's) which blurs and sometime can cross the boundary with smart water network solutions. It is important that clients have an understanding of the cost and complexity implications of adding functionality to their stack. In particular the procurement process selected needs to be well matched to reduce risk and cost for both the client and the supplier or suppliers. A collaborative or multi-stage procurement approach will be appropriate for complex scopes that often require bespoke software development and/or complex integration between several providers, when compared to the supply and install of a basic 'plug and play' smart meter solution delivering only reads and meter status data. Clients also need to consider whether they have the capacity and capability to manage commercial and performance relationships across multiple parties (meter/devices, communications, software, installation contractors) or if these are better outsourced to a third party either via by specifying an 'end to end' solution or engaging a specialist project manager.

KEYWORDS connectivity, stack, water rmeter, smart hub, visualisation, analytics, customer, investment

INTRODUCTION

Water metering has traditionally delivered a number of direct, calculated benefits including reduced overall consumption that delays or avoids the need to invest in additional supply capacity. Water suppliers have used volumetric tariff pricing techniques to influence consumers usage behaviours, providing a reasonably blunt and partially effective connection between resource and conveyance capacity constraints. A simple Return on Investment (RoI) view is often taken when assessing meter viability – a financial tool unable to capture other benefits.

New Zealand is a voluntary signatory to the United Nations Sustainable Development Goals [1]. Goal Six requires that we "Ensure availability and sustainable management of water and sanitation for all". Utilisation of domestic water metering contributes in part to achievement of this Goal. The progression to comprehensive utilisation of smart water meters could significantly advance this..

There are many broader cultural (social) and environmental (carbon, climate, ecosystem, safe to drink water) outcomes we also seek to resolve. As an example, in the United Kingdom, there are approximately 1.7 million people in "water poverty", defined as those having to spend more than 5% of their income after housing costs on water bills. A further three million are close to this point [2] . Smart metering has the potential to help address this broader social issue.

The near real-time feedback and additional functionality provided by some current and next generation smart meters complicates the simple RoI assessment. The benefits are numerous and collectively significant. Water suppliers benefits include:

- The ability to dynamically influence consumer behaviour
- Near real-time detection of events such as backflow (negative pressure), network leaks
- Measurement of network and water quality parameters e.g. temperature

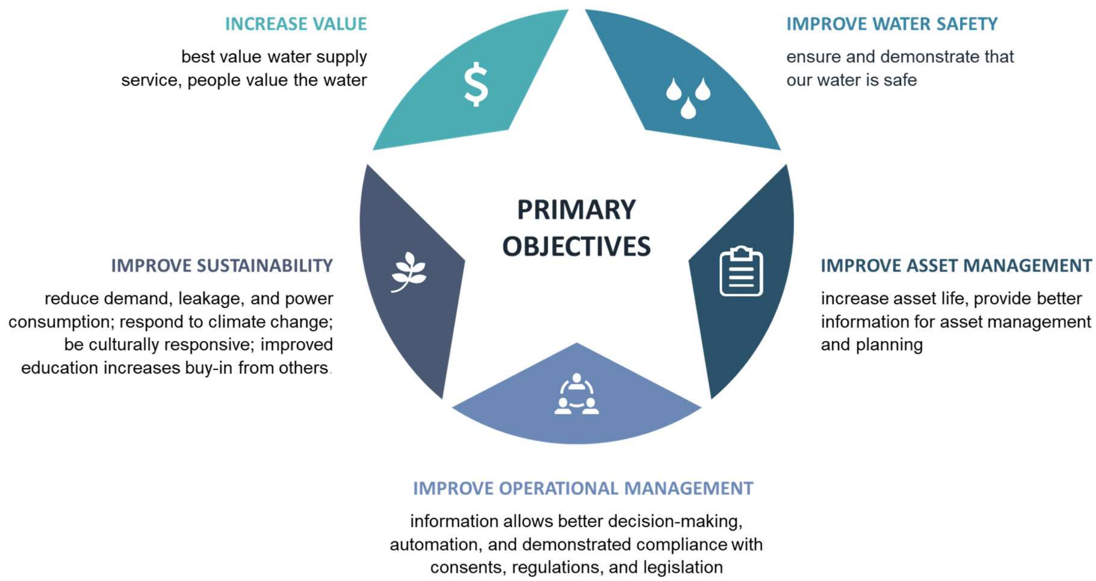
Consumer benefits include:

- Access to high cadence (hourly) information, direct to mobile devices
- Enablement to act collectively and/or competitively with their community, managing usage and cost

In this context, it is considered that the primary purposes of smart metering are as represented in Figure One. With reference to this:

- "Improve Water Safety" includes delivery and utilisation of smart meters to identify leaks – a water quality risk, identified in Water Safety Plans and
- "Improve Asset Management" includes utilisation of the information produced to enable informed targeted actions on network assets e.g. proactive targeted repairs

Figure One: Primary Objectives of Smart Water Metering



How smart metering achieves these primary and supporting purposes is considered via a technical and asset management lens.

Current State of Metering – Transition Point?

There are currently approximately two million people [3] with some type of residential water meter in New Zealand, generally of unknown age or functionality. It is likely that a very small subset of the predominantly mechanical-piston fleet of meters can be adapted to obtain pulse data – that is some form of periodic over the air (OTA) accessible data. OTA meter data is of some use depending on the frequency of that pulse e.g. 1, 10,100 litres per pulse, the aggregation which occurs e.g. `totalised into 30 minute “bins” and when it is transmitted e.g. daily. Due to mechanical meter wear and tear the quality of this information may not be sufficiently accurate, particularly for meter ten years and older.

New Zealand is at a transition point between the ability to effectively utilise its insitu meter fleet and a need to obtain improved RoI value information – which requires smart meters and an integrated system stack.

This is counterbalanced by a number of very early strategic meter adopters including Watercare, Tauranga City Council and Tasman District Council who have via a tariff pricing structure, utilising manually read mechanical meters, delayed capital investment including additional source and treatment works and influenced customer behaviours during peak demand periods.

So what is now enabling change?. Cross-over meter technologies from the oil-gas and electricity sectors have become commercially viable for domestic – household level utilisation. The water sector has utilised technologies including high quality compact ultrasonic measurement capability, long battery life extending to ten years and sub zero ambient temperature operation.

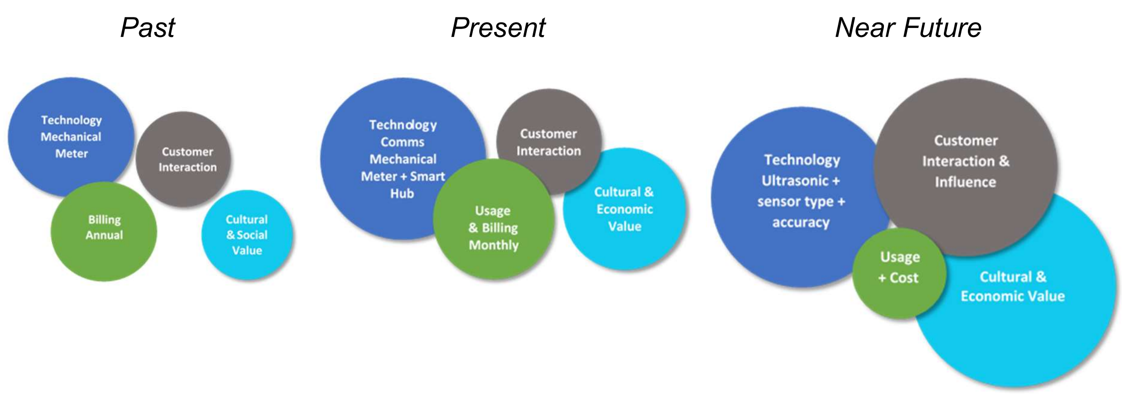
Additionally global pressure on scarce fresh water resources has driven efficiency objectives and improvements in digitisation of water services beyond the strong supervisory control (SCADA) platforms. This includes digital twin systems are enabling information from multiple sources to be matched and visualised easily. In New Zealand the requirement to demonstrate risk management through water safety plan implementation – particularly management of health based risks presented by network leakage and backflow are driving smart meter Proof of Concept (PoC) - 1-50 unit scale deployments and trials (500-40,000 unit roll-outs).

SmartMeter Progression – Past to Near Future

The four core components of metering are considered to be: meters (including operations/maintenance), billing, customer engagement and integration of social/cultural values e.g. Te Mana O te Wai. In the past there has been no joined up, hardwired connection between these four core components of smart metering.

The relative weight (importance and value) of each components and their overlap are rapidly changing due to standardisation, commoditisation, and the influence of new drivers including sustainability and customer engagement - Figure Two.

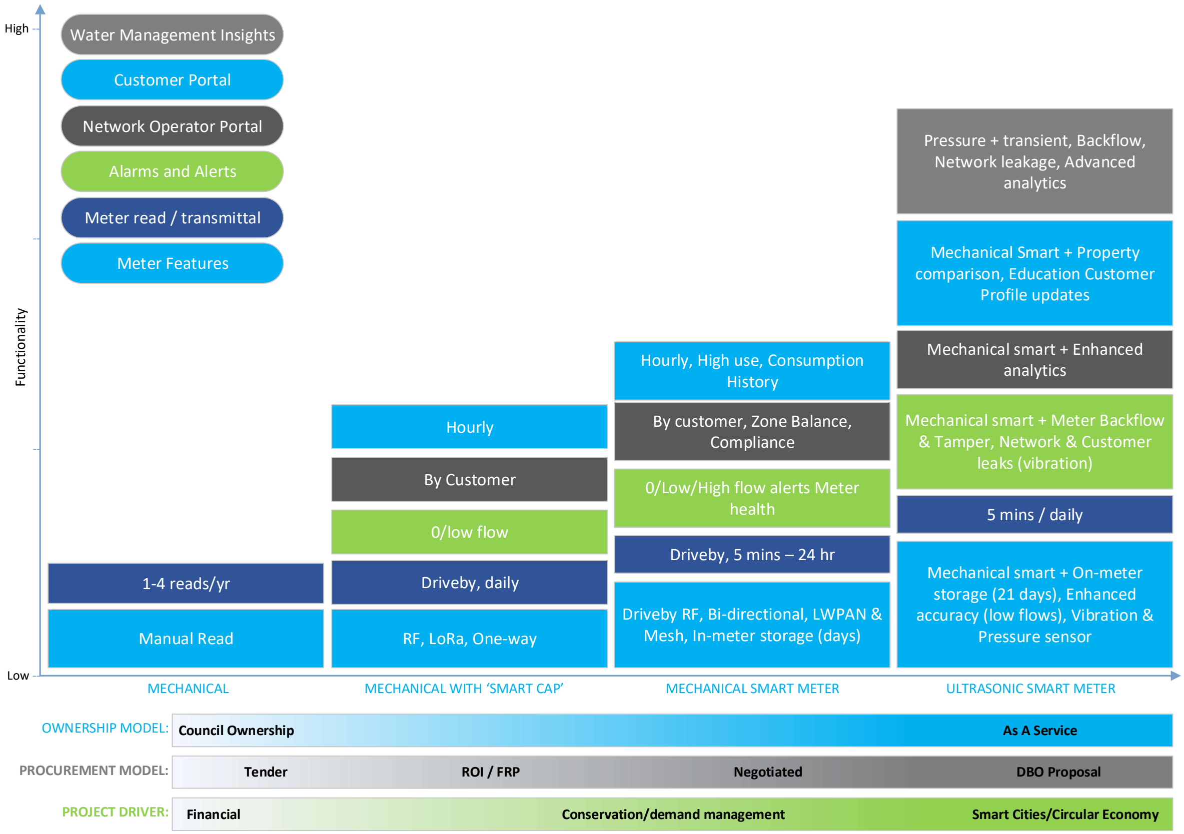
Figure Two: Smart Meters - Past, Present and Future Requirements



Metering sophistication particularly for domestic purposes has evolved rapidly over the past five years. There is now the ability at an individual domestic meter level and on a near real time basis to detect network pressure changes and accurately correlate points of leakage, reporting this back to a monitoring service or “nerve centre” – Figure Three.

At that same time the functional limits of meters are already being challenged and exceeded, particulary in biological sensing technology integration. Biological or biosensing allows for a digital reading to be produced via a bio reaction on a substrate exposed to water. In effect, detection of viruses and other targeted contaminants via domestic metered supplies is possible within five years at the current rate of development.

Figure Three: Mechanical to Smart Meter Stack – Functional Evolution

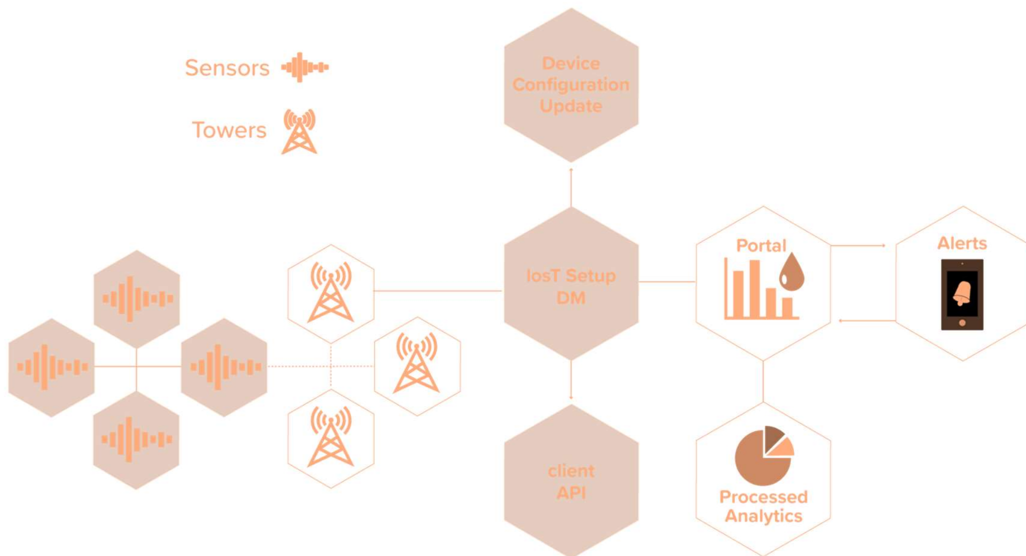


The obvious but key benefit of smart metering is provision of onboard information-to-insight, which can then drive action. There is a complex connection between meterto enable that information to action relationship to occur.

End-to-End Meter Complexity

The meter complexity can be broadly described as a set of linked critical infrastructural components - Figure Four. These componentsmust be connected in a robust and secure manner for information, insight and actions to be enabled. The requirements and risks are outlined in Table One.

Figure Four: Wireframe Smart Meter Stack Components



One of the current critical risks with this complex connected system is the potential for cyber attack, via vulnerable points where data could be accessible to “bad actors”. This includes the potential for these actors to intercept the data while inflight between the meter and tower.

Table One: Smart Meter Components – Requirements and Risks

Meter Stack Component	Requirements	Risks
Smart Meter “Sensor” End points “1000’s sensors”	Self powered, non-tamper, NZ network certified, onboard data storage	Flow range accuracy, battery life, over the air firmware upgradeable
Communications Spectrum “<10’s	Below ground penetration, reliable, low cost	Secure from inflight hacking. Available for life of meters (supported by Telcos) Proprietary network lock in
Gateways/Towers “<10”	Available with suitable spectrum ready hardware/software	Outages and recovery/uptime level of service
Data lake “1”	Securely “flat file” data, with offsite backup and duplication. Meets MBIE resilience requirements	Loss of data, corruption of information
Data warehouse “1”	Central repository where business analysts, data engineers and scientists can access information	Loss of data, corruption of information
Analytics “1”	Machine Learning algorithms, AI edge analysis, software based interrogation tools	Ability to interrogate the data and confirm validity/accuracy
Portal “1”	Operations and Customer facing access. Alerts enabled. Ability to gain simple behavioural insight, educate and adjust behaviours	Data set reliability and span (years) required before benefits may be seen

At a more detailed level communications spectrum metrics, one of the highest current risk points for smart meter success / failure is provided in Table Two. In New Zealand deployment of narrow band Internet of Things (NB- IoT) spectrum is underway, which could provide reliable below ground communications between meters and towers/gateways.

Table Two: Communications Spectrum Metrics

Protocol	Licensed Frequency	Bandwidth (+ good) (0 neutral) (- low)	Bidirectional	Ground Penetration	Range
Bluetooth	N	+	Y - full duplex	Low	10m
433 MHz	N	0	Y - full duplex	Low	1km
4G/5G	Y	+	Y - full duplex	Low	High
NB-IoT/Cat M1	Y	+	Y - full duplex	Medium	High
LoRaWan	N	-	N - half duplex	Medium	High, line of sight
Sigfox	N	-	N - half duplex	Medium	High

Procurement issues and options

Procurement of smart metering services is generally undertaken through a NZS:3916 or NZS:3917 form of contract. Buyers have recently issued tenders with up to 80 requirements, which may reflect their level of knowledge and unwillingness to take on risk. A number of of Buyer issues identified during procurement processes is provided in Table Three.

Table Three: Meter Complexity Risk Elements

Risk Element	Risk Description
People	As complexity increases, a requirement for specialist arises. This includes data analysts, programmers and network architects. Access and availability to the limited cohort of specialist is not always guaranteed. The ability to minimise complexity is highly desirable for both buyer and seller.
Scope Creep	Buyers can increase the functional requirements without undertaking a cost/benefit assessment (complexity, cost). Clear line of sight to the goal is required at the outset to avoid this if possible.
Data Security	There are various points where “bad actors” can attempt to intercept meter data. Demonstration of on-meter security, over the air encryption and at private and public access points is essential
Components	As the number of components increases, so does the complexity and potential for a fault at one point to occur and be costly to pinpoint – also refer **Redundancy**
Redundancy	With price a dominate factor, redundancy elements are often excluded

To manage procurement risk in what is an increasingly complex and technical project, several approaches have recently been taken: i) "As a Service" contracts are provided with the Buyer paying a scheduled rate for the required outcome ii) Buyers provide project management services and nominate key contractors to deliver specific services

Management of Smart Metering Projects

The management of projects requires constant, dedicated focus from the seller. With a number of specialists involved from different companies, a knowledgeable project manager who is committed to delivery is required. This role should be funded and resourced appropriately.

Conclusion

The definition of Return on Investment as the difference between input and output costs in a monetary basis is considered to be inappropriate when applied to smart metering in drinking water supplies.

Rapid disruptive evolution in smart metering is occurring now, with buyers asking "what is the right way forward to ensure intergenerational benefit?". In addition to a 100 millilitre accuracy, smart water meters now include temperature, pressure, and high resolution vibration (leakage) sensors. Integrated turbidity and bacterium sensing "biosensors" is expected to develop in the near future.

On this basis a more appropriate matrix which could be defined as the Full Cost of Recovery "plus" includes costs and benefits:

Costs	Benefits
Operational and maintenance costs Capital Costs Opportunity Costs Long Run Marginal	Cultural values acknowledgment "Te Mana O te Wai" Carbon Footprint Social and Environmental Water Safety

REFERENCES

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