WATER METERING & INTELLIGENCE · 45–60 MIN

Smart Water Metering: Turning Flow Data Into Utility Action

A controlled technical paper on hydraulic fit, measurement, communications, battery life, leak investigation, NRW, customer service and accountable water-utility action.

ORIGINAL METRO POWER PAPER

Second edition · 30 August 2026 · Review before project use

PUBLICATION CONTROL

A traceable educational edition.

This record separates publication authority from project approval. It identifies what was researched, what remains limited and when the source base must be reviewed again.

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Earlier if a controlling issuance changes

ABSTRACT

What this paper examines.

This paper connects hydraulic fit, water-meter measurement, interval data, field communications, battery life, alerts, non-revenue-water analysis and customer action. It shows why a smart-water program must be designed around a defined utility decision and a sustainable response workflow rather than around a radio feature or meter size alone.

IN SCOPE

- Potable-water customer and bulk metering concepts
- Smart-meter data and alert workflows
- Pilot, lifecycle and procurement evidence

LIMITATIONS

- Does not select a meter size or measurement principle for a real site
- Does not diagnose a leak, contamination event or commercial loss from an alert alone
- Local water, plumbing, excavation, radio and privacy requirements require authority confirmation

PHILIPPINE APPLICABILITY AND SOURCE AUTHORITY

Guidance, drafts and controlling authorities are not interchangeable.

AUTHORITY · ISO

INSTRUMENT ·

ISO 4064-1:2024

STATUS · **Published international standard · national adoption must be confirmed**

USE ·

Metrological and technical requirements for water meters

AUTHORITY · OIML

INSTRUMENT ·

OIML R 49:2024

STATUS · **Current international legal-metrology recommendation**

USE ·

Requirements, test methods and report formats

AUTHORITY · US EPA WaterSense

INSTRUMENT ·

Advanced Metering Infrastructure

STATUS · **Current utility and customer guidance**

USE ·

Frequent-use data, leak awareness and customer engagement

AUTHORITY · National Privacy Commission

INSTRUMENT ·

Republic Act No. 10173 and implementing resources

STATUS · **Philippine primary authority**

USE ·

Consumption-data privacy and lifecycle controls

ACRONYMS AND WORKING TERMS

Use the same language at every decision gate.

AMI	Advanced Metering Infrastructure
DMA	District Metered Area
NRW	Non-Revenue Water
NB-IoT	Narrowband Internet of Things
Q3/Q1	Permanent-flow to minimum-flow ratio under the applicable standard
SRS	Surveillance and Response System

REVISION HISTORY

What changed and when.

1.0	28 August 2026	Initial public web edition
2.0	30 August 2026	Research, technical-writing and editorial-control upgrade

SUGGESTED CITATION

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LEARNING OBJECTIVES

What you should be able to explain after reading.

01 Explain why hydraulic fit comes before communications

02 Trace flow measurement from the pipe into billing, network and customer workflows

03 Separate a meter alert from a confirmed leak or tamper event

04 Design a representative pilot and evidence-based selection process

SMART WATER METERING · LONG-FORM TECHNICAL EDITION

At 2:00 a.m., a household is still using water. Is it a leak?

The meter has detected a pattern. It has not discovered the cause. Understanding that difference is the beginning of responsible smart water metering.

Imagine a household connected to a water utility. Everyone is asleep, irrigation is off and no appliance is expected to run. Yet the meter records twelve liters every hour from midnight until four in the morning. The pattern repeats for three nights. A conventional monthly reading may hide this behavior inside the billing total. A smart metering system can make the pattern visible sooner. But visibility does not prove that a pipe is leaking. Continuous use can also come from a toilet valve, storage-tank filling, an appliance, occupancy, authorized nighttime activity, a meter association error or an unsuitable alert rule.

The useful system is therefore larger than the meter. It includes hydraulic selection, installation, time-stamped data, communications, platform rules, customer notification and a fair investigation process. This paper follows that overnight pattern from the pipe to a defensible utility and customer response.

THE PROMISE OF THIS PAPER

By the end, you should be able to distinguish measurement from interpretation, select a meter from real flow conditions, explain smart-water data architecture, evaluate leak and NRW claims, design a meaningful pilot and ask the questions needed before procurement.

01

THE OPERATING PROBLEM

A smart water meter is useful only when someone can act on its information

Start with the decision the utility or customer needs to make. The necessary measurement, frequency and workflow follow from that purpose.

Water utilities meter consumption for several reasons: customer billing, system accounting, non-revenue-water management, demand analysis, customer service and conservation. These purposes overlap, but they do not need identical data or operating processes.

A billing replacement program prioritizes accurate registers, controlled migration, complete reads and reconciliation at cut-off. A customer leak-notification program needs timely intervals, carefully tuned rules, understandable messages and a way to record what happened next. A district-metered-area program needs time-aligned bulk inflow and customer consumption within a defensible boundary. A facility-management program may need submetering and operating context beyond the utility account.

The US EPA describes water AMI as infrastructure that can improve the collection of frequent and accurate water-use data for billing, leak detection and resource management [1]. The important word is *can*. Data frequency creates opportunity. Operating design determines whether the opportunity becomes a useful outcome.

FIGURE 1

Four use cases, four different information requirements

Billing

Register and cut-off reads

Accepted bill determinant

Identity, units, migration and exception control

Possible leak

Frequent interval pattern

Investigated customer condition

Threshold, communication and closure process

DMA and NRW

Aligned bulk and customer data

Prioritized loss investigation

Boundary, timing and uncertainty treatment

Customer insight

Understandable usage history

Informed action

Portal access, explanation, privacy and support

What this means. One meter platform may support several purposes, but each use case needs its own data quality, timing, action owner and success measure.

This distinction also prevents technology-first procurement. Asking which radio or ultrasonic meter is “best” before defining the operating problem skips the evidence needed to make that choice. The correct opening question is: *What decision will become better, who will make it, and what information must be trusted for that decision?*

02

HYDRAULIC FIT

A meter that fits the pipe may still be wrong for the flow

Nominal diameter describes a connection. Meter suitability depends on how water actually moves through that service over time.

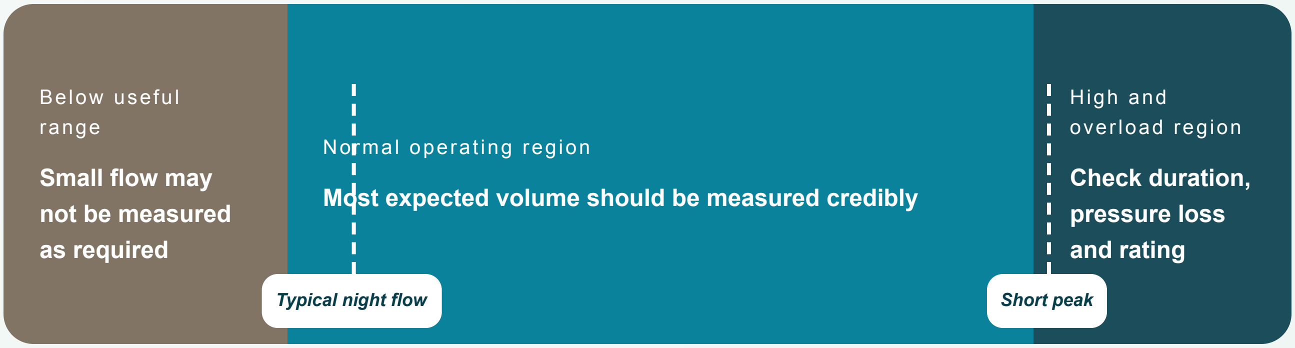
Water meters operate over defined flow conditions. The actual service has a minimum, normal and peak demand, pressure, temperature, water quality, pipe condition, installation orientation and surrounding environment. The selected meter must perform credibly across the important parts of that profile.

Oversizing is a common conceptual risk. A larger meter may appear safer because it accommodates a high peak, yet a customer can spend most of the year at low flow. If important low-flow consumption falls outside the useful verified range, the system may under-register or fail to reveal small continuous use. Undersizing creates different risks, including excessive pressure loss or operation beyond rating.

Selection should therefore consider how much time and volume occurs in different flow regions, not merely whether one design point fits under a maximum. Seasonal patterns matter. A school, hotel, hospital, industrial site and household can have very different profiles even when the pipe connection is similar.

FIGURE 2

The flow profile must sit inside the verified operating envelope



What this means. Illustrative values only. The engineering question is the exposure below, within and above the useful range, together with pressure-loss and service requirements.

Installation conditions are part of measurement

Orientation, straight-run requirements, valves and fittings, air, partially filled pipe, vibration, deposits, flooded chambers and access can influence installation quality or performance depending on the measurement principle. A laboratory result does not prove the field installation if the required conditions are absent.

The survey should document pipe material and internal diameter where relevant, direction of flow, pressure, fittings, available length, environmental exposure, accessibility, communication conditions and the work needed to replace the meter without creating a new service problem.

FIGURE 3

Hydraulic selection follows a sequence

1 Define the decision	2 Measure or estimate flow profile	3 Confirm pipe, pressure and water conditions	4 Compare measurement principles	5 Check installation geometry
6 Evaluate lifecycle and communications	7 Approve exact model and size			

What this means. The sequence keeps the use case and field evidence ahead of product preference.

03

MEASUREMENT PRINCIPLES

Mechanical, ultrasonic and electromagnetic meters observe flow differently

No measurement principle is universally superior. Each must be evaluated against the water, installation, operating range and lifecycle obligation.

A **mechanical meter** uses water movement to drive a measuring element and register volume. The specific design may differ, but moving components, debris, wear, installation and low-flow behavior deserve attention. Mechanical technology can be well understood and practical, but suitability depends on the exact application and evidence.

An **ultrasonic meter** commonly infers flow by comparing acoustic transit behavior along a known path. It does not rely on a traditional moving measuring element, which can reduce some wear mechanisms. However, acoustic path, air, deposits, geometry, electronics, transducers, power and temperature still matter. “No moving parts” does not mean “no failure modes.”

An **electromagnetic meter** infers velocity from the electrical response of conductive fluid moving through a magnetic field. It can suit larger or network applications under appropriate conductivity, lining, grounding, power and installation conditions. It should not be selected from a general claim without confirming those boundaries.

FIGURE 4

Measurement principles convert the same physical flow through different evidence chains

MECHANICAL

Flow moves an element

Motion → register

Watch low flow, wear, debris and pressure loss.

ULTRASONIC

Acoustic transit changes

Signal timing → calculated flow

Watch air, path condition, installation and battery assumptions.

ELECTROMAGNETIC

Conductive flow induces signal

Electrical response → calculated flow

Watch conductivity, lining, grounding, power and geometry.

What this means. The exact product can differ from the simplified description. Compare verified range, uncertainty, pressure loss, installation, power, maintenance and lifecycle evidence.

MODEL-SPECIFIC BOUNDARY

Performance claims, ratios, accuracy classes, flow points, orientation, battery life and alert functions must match the exact model, size, configuration and current evidence. Product-family language is not evidence for every offered configuration.

04

FROM VOLUME TO INTERVAL DATA

A monthly total and an hourly pattern answer different questions

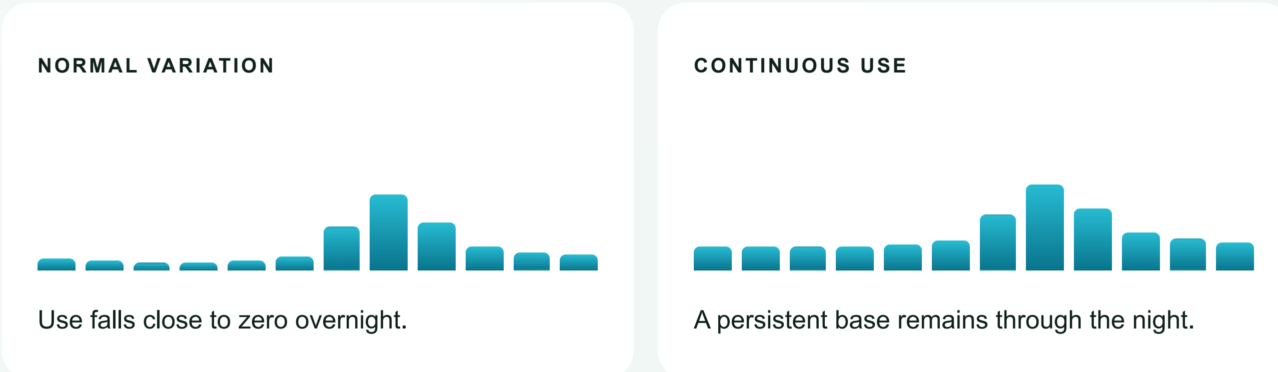
Smart metering adds time to consumption. That makes patterns visible, but it also makes clocks, identity and missing data more important.

A cumulative register tells the utility how much volume has passed since the register began, subject to units, rollover and configuration. The difference between two controlled reads supports consumption over that period. Interval data distributes consumption across defined periods, such as an hour or fifteen minutes.

Return to the household using twelve liters per hour overnight. The monthly register alone includes those liters but does not isolate the pattern. Hourly intervals show continuous use. They still do not reveal whether the cause is a leak, toilet valve, tank, appliance or intentional activity.

FIGURE 5

The same monthly consumption can contain very different patterns



What this means. Illustrative profiles. Total volume alone cannot show timing, persistence or customer operating behavior.

Each interval needs the meter identity, location or account relationship, timestamp, unit and quality state. Migration from an old meter to a new one must preserve the final old register, initial new register, cutover date, serials, units and any multiplier or configuration. If the physical and digital relationships are wrong, frequent data can accelerate incorrect billing rather than improve it.

Missing, late, duplicate or corrected readings require approved handling. A portal should not silently draw a smooth line through absent data. A billing process should preserve whether a value was measured, estimated or edited. More data creates more responsibility for quality and explanation.

TEACHING CASE

A convincing leak graph attached to the wrong customer

Two adjacent meters are exchanged in the customer database during migration. One house has continuous overnight use; the other does not.

Both meters measure and communicate correctly.

The platform detects a real pattern but associates it with the wrong account.

The wrong household receives a leak notice and loses confidence in the program.

The corrective action is identity reconciliation, not threshold adjustment.

What the case teaches

Data quality begins with asset identity. Analytics cannot repair an incorrect meter-to-account relationship.

05

COMMUNICATIONS AND POWER

Frequent data depends on a network and an honest battery model

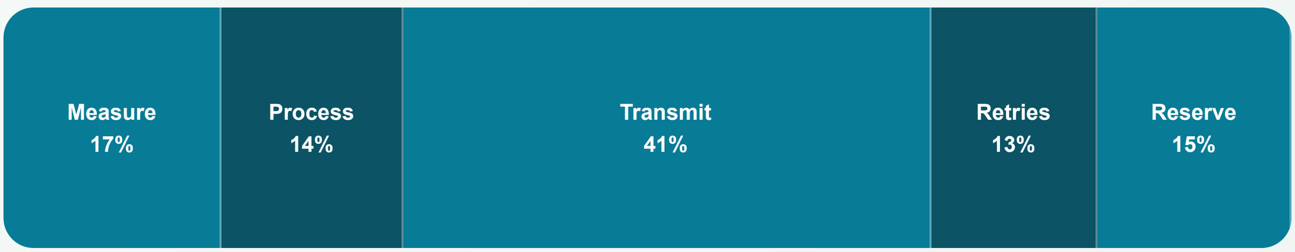
A water endpoint may need to measure for years in a chamber or service location without mains power. Every transmission and retry consumes part of that operating life.

Smart water data can move through fixed radio networks, cellular services, gateways or other supported architectures. The design problem resembles electric AMI in some ways, but battery-powered endpoints make duty cycle especially important. Sampling, local processing, transmission frequency, retries, signal strength, temperature, alarm behavior and battery aging all contribute to energy consumption.

A claim such as “battery life up to fifteen years” is incomplete without assumptions. How often is flow sampled? How often is data transmitted? How many retries are assumed? What temperature range applies? Does the estimate include frequent alarms, weak coverage and the reserve needed to preserve operation at the end of life? Is the battery replaceable, and what happens to sealing or certification after replacement?

FIGURE 6

An illustrative endpoint energy budget



What this means. The proportions are educational, not a product specification. A supplier life claim should expose the duty-cycle assumptions behind every major energy use.

Coverage should be assessed at the actual meter location. A signal observed at street level does not prove reliable communication inside a concrete chamber, metal enclosure or building service room. The pilot should measure sustained delivery, latency, retries and battery indicators across difficult as well as favorable sites.

Collection frequency and transmission frequency are also different. An endpoint may record fifteen-minute consumption but send a batch every several hours. This can preserve battery and network capacity, but it changes how quickly the utility can detect a condition. Requirements should state both the interval represented by the data and the deadline for receiving it.

FIGURE 7

Measurement frequency and delivery frequency shape the service

MEASURE		STORE		TRANSMIT		NOTIFY
Every 15 minutes	→	**Four intervals**	→	**Every hour**	→	**After validation**
Creates detailed local intervals		Retained securely in the endpoint		Subject to coverage and retry		Timing follows the alert workflow

What this means. More frequent measurement improves pattern resolution. More frequent transmission can reduce notification delay but increases network and energy demand.

06

ALERT INVESTIGATION

A continuous-flow alert should begin a question, not make an accusation

Algorithms recognize patterns under configured rules. Utilities and customers establish the cause through context and investigation.

A continuous-flow rule might ask whether consumption stayed above a threshold during every interval in a defined window. Another rule may compare current behavior with the account's historical baseline. A commercial property, household, hospital and irrigation account need different interpretation. One universal threshold can overwhelm the utility with expected activity or miss conditions important to a smaller customer.

EPA guidance for incorporating AMI into a water surveillance and response system treats alert investigation procedures as a distinct design element, alongside equipment, communications and information management [2] . This is an important principle: detection and response must be designed together.

FIGURE 8

From flow pattern to closed investigation

1

Pattern

Configured rule detects continuous or unusual use

2

Data check

Identity, time, completeness and meter status

3

Context

Customer class, history and known operations

4

Communication

Careful notice describing a possible condition

5

Investigation

Customer check, field work or other authorized review

6

Closure

Cause, action, verification and rule feedback

What this means. The utility should preserve uncertainty until evidence supports a conclusion. Closure includes confirmed cause, action and verification.

WORKED ALERT CASE

Twelve liters per hour from midnight to 04:00

The pattern appears for three nights on a residential account.

Validate data. Confirm meter identity, interval completeness, clock, unit and whether any communication gap was filled by estimation.

Review context. Compare previous weeks, customer class, irrigation schedule and known tank or appliance behavior.

Communicate uncertainty. Tell the customer that continuous use was observed and may indicate a leak or other ongoing demand.

Support investigation. Suggest safe fixture and isolation checks under the utility's approved customer guidance.

Verify closure. After a repair or explanation, confirm whether the overnight baseline changed.

What the case teaches

The program should measure confirmed actionable conditions and successful closure, not simply the number of alerts generated.

Alert sensitivity can reduce program effectiveness

Lowering a threshold usually increases detection volume. It can also increase false positives, customer fatigue and unresolved backlog. A useful metric is the proportion of investigated alerts that lead to confirmed actionable conditions, reported by alert type and customer segment. Another is median time to closure.

07

NON-REVENUE WATER

Customer meters contribute to a water balance, but they do not locate every loss

NRW analysis is a system-accounting problem involving boundaries, time alignment, meter uncertainty, authorized consumption and field investigation.

Non-revenue water is not synonymous with physical leakage. Under the utility's adopted accounting method, it can include real losses, apparent losses and authorized unbilled consumption. Customer meter under-registration, data gaps, account issues and unauthorized use can affect the apparent-loss side. Main and service-pipe leakage affect real losses. The utility needs a structured balance before assigning cause.

A District Metered Area, or DMA, defines a controlled network boundary. Bulk inflow is compared with authorized consumption over aligned time periods, with storage effects, imports, exports and data quality considered. Customer AMI can improve the timeliness and granularity of this comparison, but only when bulk and customer clocks, intervals and boundaries agree.

FIGURE 9

A DMA residual is an investigation signal, not automatic leakage

System input volume
Aligned bulk inflow adjusted for boundary and storage

–

Authorized consumption
Billed and authorized unbilled consumption

=

Water-loss residual
Apparent and real loss subject to uncertainty

What this means. Timing error, missing reads, meter uncertainty and authorized unbilled use can occupy part of the residual. Reconcile them before prioritizing field location work.

WORKED DMA CASE

A 12.5 percent difference distorted by time and missing data

A DMA bulk meter reports 1,200 m³ from midnight to midnight. Customer meters total 1,050 m³, but 20 percent report on a six-hour offset and 4 percent of endpoints are missing.

The unadjusted difference is 150 m³, or **12.5 percent** of bulk input.

The comparison mixes different time windows, so network storage and demand timing can distort the difference.

Missing customer endpoints require an approved quality treatment, not silent assumption.

Authorized unmetered use, meter uncertainty and boundary status must be documented.

Only the reconciled residual should guide leak-location priorities.

Smart customer meters also do not physically locate a main leak. Utilities still need pressure information, acoustic or other field methods, asset knowledge, repair records and verification. AMI helps narrow questions and measure change. It does not remove the need for water-loss engineering.

08

CUSTOMER EXPERIENCE

A useful portal explains water behavior without overstating certainty

Customers need timely information, understandable units, practical next steps and a fair route to question the result.

EPA guidance for facility managers explains how frequent AMI data can reveal trends, unexpected use and possible leaks before a bill arrives [3] . For a household, the same principle can turn a monthly surprise into an earlier question. The interface should show the reading period, unit, data delay, estimated or measured status and comparison basis.

A graph alone is not education. If the portal shows 0.012 m^3 per hour, many customers will not immediately recognize twelve liters. If it flags “leak detected,” it may state more certainty than the evidence supports. Better language is specific: “Continuous consumption averaging approximately twelve liters per hour was observed between midnight and 04:00 for three nights. This can indicate a leak or another source of ongoing water use.”

FIGURE 10

A responsible customer notification has five parts

1

Observation

What pattern was measured?

2

Translation

What does the volume mean in familiar units?

3

Uncertainty

What are the possible explanations?

4

Action

What safe checks or contacts are available?

5

Follow-up

How will the result be confirmed or challenged?

What this means. Specific evidence and careful uncertainty help the customer act without turning an algorithmic pattern into an unsupported conclusion.

Privacy and inclusion also matter. Water-use profiles can reveal occupancy and operating patterns. Access, third-party disclosure, retention and correction should be governed. Customers without reliable internet or digital confidence need an alternative channel. A smart system should widen the utility's ability to help, not narrow the customer's ability to be heard.

09

PILOT AND ACCEPTANCE

A credible pilot tests the meter, the network and the response workload together

The purpose of a pilot is to reduce uncertainty before scale, including uncertainty about how much work the new information will create.

A representative pilot should include varied flow profiles, customer classes, pipe and chamber conditions, indoor and buried locations, difficult radio environments, battery stressors and real billing cutover. It should test the complete path from measurement to platform, billing, alert communication and closure.

Acceptance measures should include register reconciliation, interval completeness, scheduled delivery, retry behavior, alert confirmation, false-positive rate, customer contact, exception aging, battery indicators and integration outcomes. A high read-success rate can coexist with poor alert usefulness or incorrect account migration.

FIGURE 11

Pilot evidence must cover four planes

HYDRAULIC	DATA	NETWORK	OPERATIONS
Meter fit	Trusted intervals	Sustained delivery	Closed action
Flow, pressure and installation	**Identity, time and quality**	**Coverage, retry and battery**	**Alerts, support and maintenance**
Prove measurement conditions.	Prove billing and analytical integrity.	Prove difficult locations.	Prove workload and ownership.

What this means. Scaling requires evidence that the planes operate together, not four unrelated demonstrations.

WORKED PILOT CASE

More sensitive alerts create a growing backlog

A utility lowers its continuous-use threshold. Weekly alerts rise from 40 to 210, while investigators can close only 70.

Alert generation rises by **425 percent**.

The unresolved backlog grows by 140 cases every week.

Customer messages become slower and less relevant.

The utility should segment rules, measure confirmed conditions and retest workload capacity.

What the case teaches

The objective is not maximum alert volume. It is timely, accurate and sustainable action.

FIGURE 12

Pilot-to-scale evidence gates

GATE 1

Use case and baseline

GATE 2

Hydraulic survey

GATE 3

Exact configuration

GATE 4

Representative installation

GATE 5

Sustained operation

GATE 6

Billing and response acceptance

What this means. Each stage should close its critical exceptions or carry an approved, funded remediation plan into the next decision.

10

ECONOMICS AND LIFECYCLE

Count meter replacement, communications, batteries and

operating response

The business case must follow the system through installation, operation, maintenance and replacement, not stop at unit price.

Cost can include meters, endpoints, gateways, network or carrier service, platform licensing or hosting, integrations, installation, chamber rehabilitation, migration, customer communication, training, battery or endpoint replacement, support, spares and disposal. A low meter price can be overwhelmed by difficult installation or an unsupported battery assumption.

Benefits may include reduced manual reading, fewer estimates, earlier customer leak response, improved billing, prioritized field work and better water-balance evidence. Each needs a verified baseline and achievable change. Avoid counting the same field visit under both reading and truck-roll savings. Separate cash savings, avoided future cost, service improvement and water-conservation value.

FIGURE 13

Lifecycle value is a sequence of costs and outcomes

1	**Year 0**	Survey, product, installation, integration
2	**Years 1–2**	Stabilization, exceptions, customer adoption
3	**Operating years**	Network, platform, support and verified benefits
4	**Replacement window**	Battery, endpoint or meter intervention
5	**End of life**	Migration, disposal and service continuity

What this means. Timing matters. Benefits normally ramp after migration and process adoption, while replacement and support costs continue through the asset life.

11

PROCUREMENT AND PHILIPPINE APPLICATION

Procure a measurement and response capability with evidence at every boundary

The specification should connect the use case to flow conditions, exact product evidence, information architecture and acceptance.

The requirement should define use cases, pipe and flow conditions, metrological performance, pressure, environment, installation, register and interval behavior, communications, battery assumptions, data fields, interfaces, alerts, cybersecurity, migration, testing, training, warranty, spares and support. Evidence must match the exact model and size offered.

Before bidding

Confirm use cases, flow profile, sites, interfaces, operating owners and evidence gaps.

Before award

Resolve deviations, data rights, battery assumptions, lifecycle cost and acceptance method.

Before production

Freeze model, size, endpoint, configuration, firmware, accessories and tests.

Before installation

Approve survey, geometry, identity migration, field records and customer communication.

Before billing cutover

Reconcile old and new registers, units, dates, accounts and exceptions.

Before scaling

Prove sustained data delivery, alert quality, workload capacity and lifecycle model.

Before final acceptance

Deliver as-builts, configuration, training, warranty, spares and replacement plan.

Before end of life

Protect data continuity, revoke access and control battery or equipment disposal.

PHILIPPINE APPLICATION

Confirm the water utility's approved specifications, relevant national and local water, plumbing, public-health, radio-communications, privacy, electrical, excavation and permit requirements, and the authority responsible for acceptance. International sources in this paper provide technical and operating guidance, not automatic Philippine compliance.

Questions the reader should now be able to ask

What decision requires frequent water-use information?

What are the actual minimum, normal, peak and seasonal flows?

Which measurement principle and size fit those conditions?

How do interval, transmission and notification frequency differ?

What assumptions support battery life?

How will possible-leak alerts be investigated and closed?

Are DMA boundaries, bulk reads and customer reads time aligned?

Which claims are proven for the exact offered configuration?

THE COMPLETE CHAIN

Smart water metering succeeds when a pattern becomes a responsible action

Return to the household at 2:00 a.m. The meter records continuous use. The endpoint stores and transmits the intervals. The platform validates identity and time. An approved rule identifies the pattern. The utility explains what was observed without pretending to know the cause. The customer or utility investigates, takes action and verifies the result.

The meter made the condition visible. The operating system made the information useful.

NUMBERED REFERENCES

Primary sources used in this edition

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Using AMI in a Water Quality Surveillance and Response System

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Improving Water Management Using AMI Data

US EPA WaterSense, 2022. Understanding consumption, unusual use and facility action.

Leak Detection and Flow Monitoring Devices

US EPA WaterSense. Consumer leak-detection and flow-monitoring context.

Control and Mitigation of Drinking Water Losses in Distribution Systems

US EPA. Water-loss-control planning context.

This is an original Metro Power educational synthesis. Figures and cases are original unless otherwise stated. Illustrative data is not a project benchmark.

SECOND-EDITION TECHNICAL REVIEW

Second-edition evidence review: flow range, data timing and actionable alerts

Smart-water value begins with credible hydraulic measurement and ends with a response process that preserves uncertainty until evidence supports a conclusion.

01

Pipe diameter alone does not show whether minimum, normal, peak and seasonal flows fall inside the useful range of the exact meter and installation.

02

A meter may record frequently and transmit in batches. State the interval represented, delivery deadline, retry behavior and battery assumptions independently.

03

Continuous flow, reverse flow or tamper logic detects a configured pattern. Context and field evidence establish the cause.

Water-meter selection and pilot evidence should follow the complete hydraulic-to-action chain.

Boundary
Pipe to meter

Required evidence
Flow profile, pressure, orientation, water quality and installation geometry

What can go wrong
Meter is physically fitted but poorly ranged

Owner
Hydraulic engineer

Boundary
Meter to endpoint

Required evidence
Register, pulse or data identity and power budget

What can go wrong

Wrong unit, rollover or battery assumption

Owner

Metering owner

Boundary

Endpoint to network

Required evidence

Coverage, retries, latency and delivery window

What can go wrong

Street-level signal hides chamber loss

Owner

Communications owner

Boundary

Platform to billing

Required evidence

Account mapping, time, quality and correction rules

What can go wrong

Good reads attach to wrong account

Owner

Billing and data owner

Boundary

Alert to action

Required evidence

Threshold, context, communication and closure

What can go wrong

Nuisance alarms overwhelm response

Owner

NRW or customer-service owner

WORKED EVIDENCE CASE

Comparing a DMA before calling the residual a leak

A bulk meter reports 2,400 m³ for a day. Customer intervals total 2,080 m³, but 6 percent of endpoints are missing and part of the customer data uses a six-hour offset.

- Unadjusted residual is 320 m³, or 13.3 percent of bulk input.
- Align the bulk and customer time windows before comparing demand.
- Apply the utility’s approved treatment for missing customer data and state uncertainty.
- Account for authorized unbilled consumption, imports, exports and storage or boundary effects.
- Review bulk and customer meter performance.
- Use the reconciled residual to prioritize field investigation; do not label the full 320 m³ as physical leakage.

DECISION LESSON

Granular data improves the water balance only when identity, time, completeness and boundaries are controlled.

FAILURE-MODE REVIEW

What to challenge before commitment.

Low-flow performance or pressure loss is misunderstood

Evidence: Measured or defensible flow profile

Lifecycle cost and service continuity are overstated

Evidence: Configuration-specific power budget

Customer trust and investigation quality decline

Evidence: Data validation and closure workflow

Compliance claim exceeds the evidence

Evidence: Authority and utility acceptance record

VERIFIED CONTEXT

- ISO 4064-1:2024 and OIML R 49:2024 provide current international metrological frameworks
- Republic Act No. 10173 applies to personal-data processing in the Philippines

VERIFY FOR THE PROJECT

- National or utility adoption of the exact water-meter standard
- Radio, plumbing, water-quality, excavation, electrical and local requirements
- Billing, customer-notification and dispute procedures of the responsible utility

PROJECT GATE

Proceed from pilot to scale only when hydraulic fit, exact product evidence, sustained communications, billing integration, alert workload and local authority requirements are accepted together.