Guideline

Energy Metering and Monitoring

E-GDE-STD-001

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Ver No.	Description	Document Owner		Document Approver		
		Position	Approval	Position	Approval	Approval Date
1	Original Version	Principal Energy Advisor - P7415	Refer to supporting Info in Rex	Manager DTI Performance - P7659	Refer to supporting Info in Rex	21/04/2023
This Electrical Guideline was endorsed by an RPEQ Registration on behalf of Seqwater.						

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1. Purpose

The purpose of this Guideline is to guide on assessing the need, justification and selection of energy metering and monitoring equipment during planning, procurement, engineering and construction of all new assets and all existing assets undergoing refurbishment, modification, or upgrades.

The guideline forms part of a suite of energy efficiency guidelines, manuals, standards, and frameworks that are integral to delivering Seqwater's Energy Strategy (PLN-00452). The alignment of this document with the Energy Strategy is detailed in Section 4.2.

2. Scope

This Guideline applies to all workers or all employees unless otherwise stated. The scope of metering within this Guideline applies to three categories:

- Energy Metering
- Performance Metering
- Submetering

3. How to Read this Guideline – Document Map

A document map is included in Figure 1 to aid navigation of this Guideline. Users may refer to the document map to navigate to relevant sections as required.

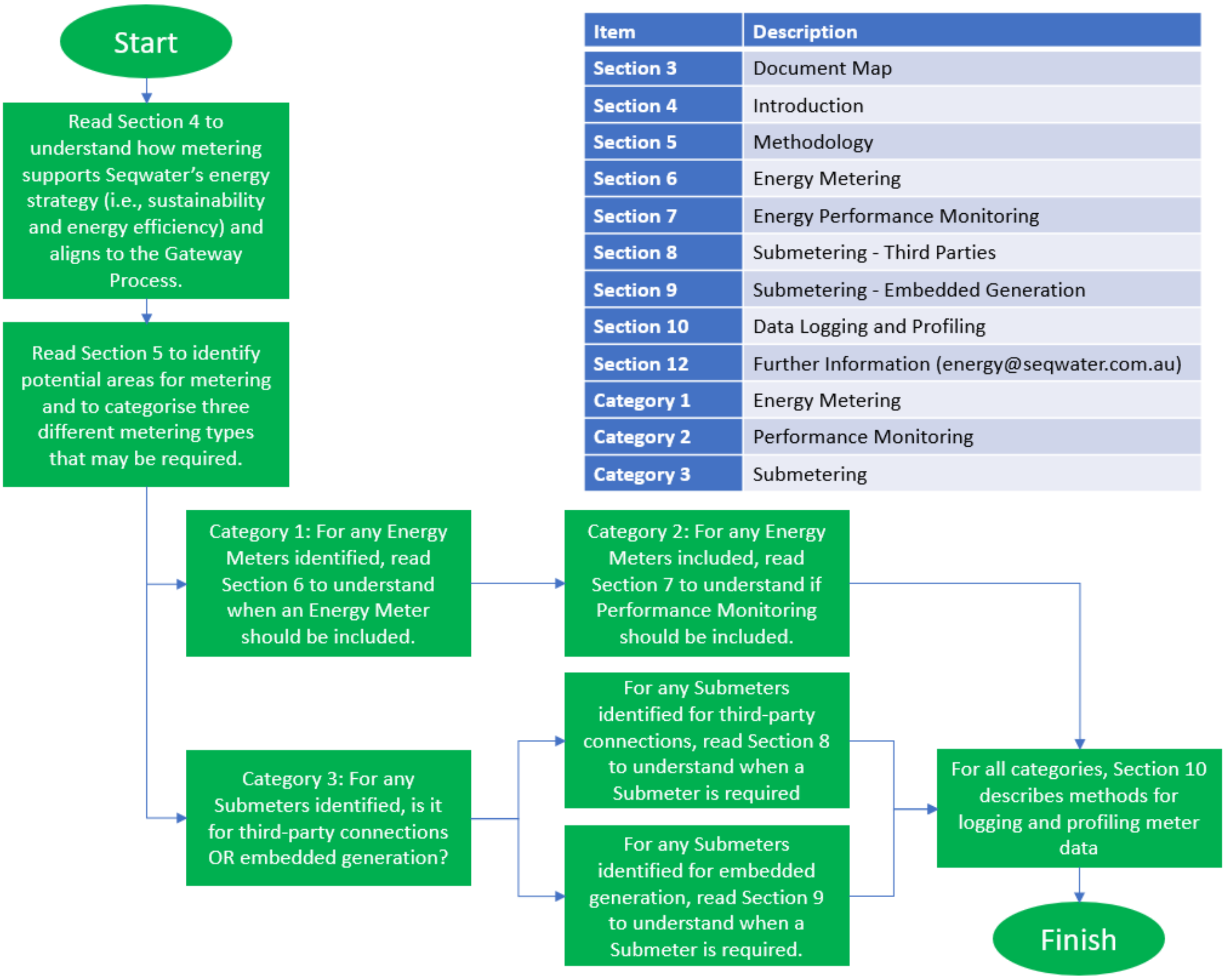

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Figure 1: Document Map

4. Introduction

Seqwater consumed over 213GWh of electricity in FY 2020/21 (excluding small market sites) at a total cost over $26.8M.

For all electricity consumers within the National Electricity Market (NEM), energy usage and associated costs are derived through metering data. This data is obtained from revenue-grade electricity meters installed at the site's network connection point. At the time of writing, Seqwater has 67 large sites capturing data in half-hourly intervals and 173 small sites recording total consumption data.

Although this data is helpful in understanding how each site is consuming energy, there is insufficient granularity to utilise this information for selective or targeted assessments of sub-process within.

To achieve Seqwater's strategic energy outcomes, a more granular view of energy usage is required. Metering is an essential enabler to the successful delivery of energy improvement projects and is vital for the ongoing benefits realisations of these initiatives.

Considerable the significant spending on energy and the benefits obtained from increased metering, implementing a comprehensive fit-for-purpose metering infrastructure is highly recommended.

4.1. Purpose and Scope

This document guides on assessing the need, justification and selection of energy metering and monitoring equipment during planning, procurement, engineering and construction of all new assets and all existing assets undergoing refurbishment, modification or upgrades.

The guideline forms part of a suite of energy efficiency guidelines, manuals, standards and frameworks that are integral to delivering Seqwater's Energy Strategy (PLN-00452). The alignment of this document with the Energy Strategy is detailed in Section 4.2.

Users will apply this Guideline alongside Seqwater's capital investment gateway process to guide metering and monitoring during each stage. This guidance will ensure that projects significantly affecting the use of energy at Seqwater will have an appropriate level of metering and monitoring installed to enable meeting strategic energy objectives (Section 4.2).

Seqwater's gateway process will include an "Energy Efficiency Checklist" (REX link D21/61965) to ensure that projects are flagged for metering and monitoring opportunities.

Figure 2 outlines Seqwater's gateway process and identifies where this Guideline applies to each stage.

The scope of metering within this Guideline applies to three categories:

- Energy Metering
- Performance Metering
- Submetering

Energy Metering is included to realise efficiency through increased visibility of energy consumption.

Performance metering is included to capture process and operational information to facilitate Energy Performance Indicators (EnPIs). Performance metering is also included to identify opportunities for resource optimisation (e.g., energy consumption, chemical consumption, asset life cycle planning).

Submetering is included to facilitate cost recovery from third party entities consuming energy from Seqwater. Submetering is required to capture generation data from embedded renewables. Submetering is also used to identify the breakdown of energy consumption for multiple facilities within a single site.

Although each site has an electricity meter at its connection point, these are installed for electricity billing and are managed by an accredited Metering Provider (MP). These meters are not included in the scope of this Guideline.

This Guideline does not cover the standards or specifications required for the design, installation and commissioning of meters. It also does not cover gas and water metering. The scope limit of this Guideline concerning system architecture is from the meter's sensing transducers to the meter's communication interfaces, including connectivity requirements to other systems.

The limit of scope is outlined in Figure 3.

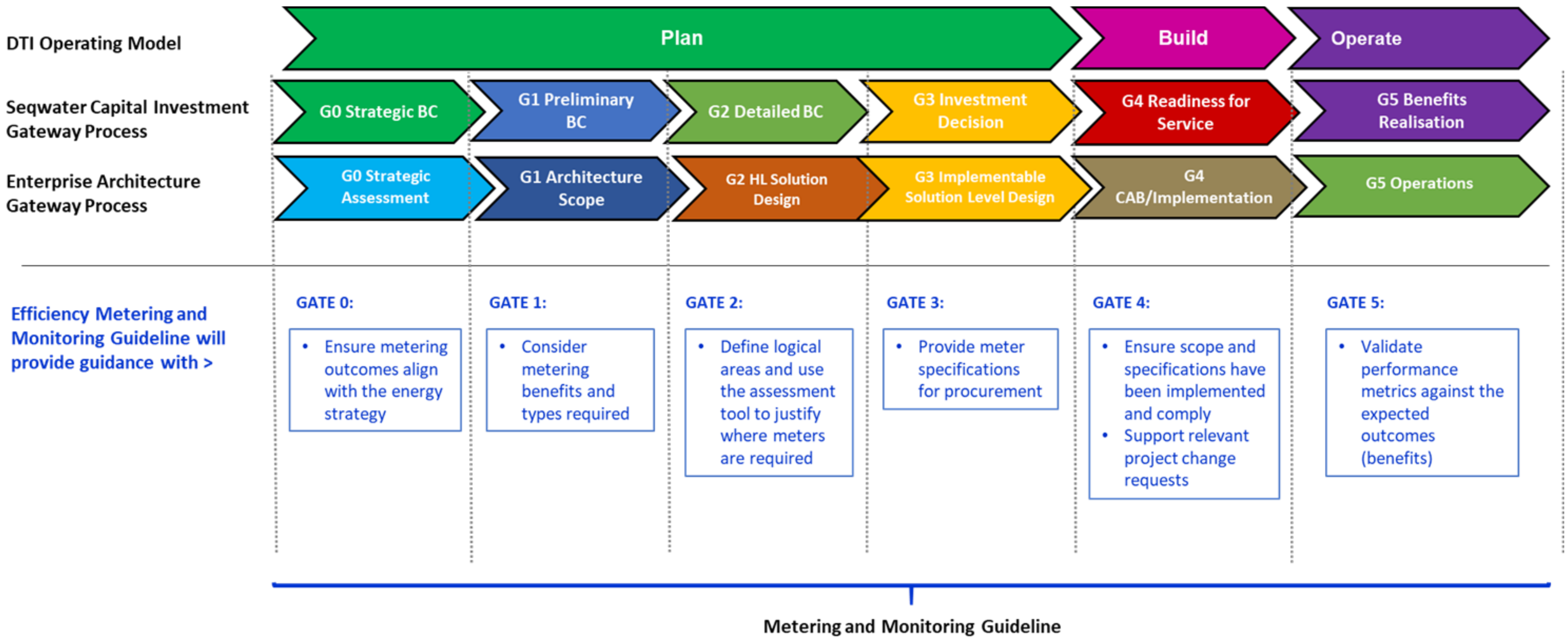


Figure 2: Alignment with the Gateway Process*

*The Gateway Process is current at the time of writing

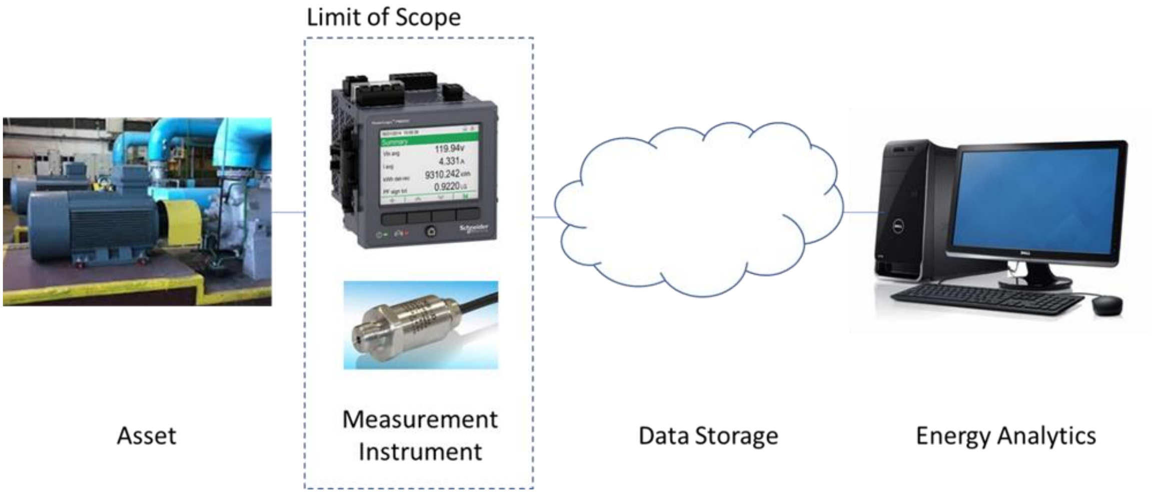


Figure 3: Conceptual diagram outlining scope boundaries

4.2. Strategic Alignment

The Metering and Monitoring Guideline (this document) is designed to support specific outcomes delivered by implementing a comprehensive metering and monitoring system. These outcomes are designed to align with and underpin Seqwater's Strategic objectives as defined in the Energy Strategy (PLN-00452).

1. Objective 1 - Support the achievement of sustainability targets.
   a. Support achieving Seqwater's net-zero carbon target and other sustainability and compliance targets
2. Objective 2 - Ensure energy security.
   b. Ensure energy security to support water supply certainty
3. Objective 3 - Use energy more efficiently.
   c. Implementation of energy efficiency initiatives to reduce both energy usage and costs

A list of specific metering outcomes and how they align with Seqwater's energy objectives are outlined in Table 1.

Outcome	Description	Objective 1	Objective 2	Objective 3	Other Objective[1]
Increase the visibility of energy utilisation	Increased visibility of energy usage enabled by metering will uncover energy efficiency opportunities and reduced consumption			✓	

[1] Objective relating to asset management or regulatory compliance

Outcome	Description	Objective 1	Objective 2	Objective 3	Other Objective1
Improve monitoring of carbon emissions	Increased granularity of consumption enabled by metering will improve visibility of indirect emissions, assisting with carbon reporting and tracking	✓			
Optimise Capacity Requirements	Improved energy metering will assist in understanding daily demand profiles. This can be used to optimise network capacity and backup power requirements.		✓		
Reduce Network Charges	Increased visibility of power usage enabled by metering will uncover opportunities for reducing maximum demand charges			✓	
Generate key performance metrics	Marrying consumption data with the site's process and operational information will allow for the creation of energy performance metrics			✓	✓
Improve asset management	Increased monitoring of energy usage and asset performance will facilitate improved asset management				✓
Drive behavioural change	Increased awareness of energy usage will enable behavioural changes (improved sustainability culture)			✓	
Enable the EMaAP platform	Granular energy consumption data will enable the Energy Monitoring and Analytics Platform (EMaAP) system			✓	
Regulatory compliance	Compliant metering is required when on-selling electricity and when generating clean energy certificates				✓

Table 1: Alignment with strategic energy objectives

Primarily these outcomes align with Seqwater's Energy Strategy by providing increased visibility of energy usage. Some outcomes pertain to asset management or regulatory compliance, highlighting the broad nature of the metering benefits.

4.3. Benefits

Unlike equipment upgrade projects or process improvement works, the costs and benefits of installing a meter can be difficult to determine. The benefits of installing a meter arise from capturing more information, and the additional information enables Seqwater to make informed decisions on plant operations and asset management.

Additional metering increases the visibility of underlying processes and systems needed to uncover opportunities for improvement. Once optimised, metering can ensure that processes and systems continue to operate at their best and monitor that performance does not deteriorate over time.

Metering benefits can be divided into tangible and intangible. As metering is either an enabler to uncover inefficiencies or a mandated requirement for compliance, most benefits will be intangible. Some benefits can be considered tangible by way of "assumed" quantifiable savings.

Specific benefits for metering differ for each of the three categories covered by the scope of this Guideline. A non-exhaustive list of benefits for each category is outlined in Table 2, Table 3 and Table 4.

Energy Metering Benefits	Tangible	Intangible
▪ Monitoring of performance against EnPIs		✓
▪ Uncovering inefficiencies	✓	
▪ Confirmation of Energy Conservation Measures		✓
▪ Improved visibility of Scope 2 carbon emissions ($CO2_e$)		✓
▪ Improved Demand Management	✓	
▪ Monitoring usage for energy awareness		✓
▪ Improved Asset Management (e.g., maintenance savings)	✓	
▪ Monitoring to inform behavioural changes		✓
▪ Informed decision making		✓
▪ Improved reporting		✓

Table 2 Energy Metering Benefits

Submetering Benefits	Tangible	Intangible
• Cost recovery from third parties	✓	
• Cost allocation, forecasting and budgeting	✓	
• Capturing gross generation of renewable assets		✓
• Regulatory compliance for electricity on-selling		✓
• Regulatory compliance for certificate generation		✓
• Confirmation of investment returns	✓	
• Improved granularity of Sub-divided sites		✓

Table 3 Submetering Benefits

Performance Monitoring Benefits	Tangible	Intangible
• Improved asset planning		✓
• Risk mitigation		✓
• Capital deferral	✓	
• Reactive maintenance	✓	
• Improved alarming	✓	

Table 4 Performance Monitoring Benefits

4.4. Users of this Guideline

This Guideline is intended for three primary user groups:

1. Strategy, planning, delivery and asset management teams from Customer Strategy and Planning (CSP), Major Projects, and Planning, Operations and Delivery (POD) groups
2. Operations and maintenance teams from the POD group
3. Seqwater consultants and contractors

Personnel from the teams mentioned above are encouraged to utilise this Guideline in all stages of the gateway process to assist in the planning, development, and delivery of asset investments.

Operations and maintenance staff may utilise this Guideline to understand the key elements and drivers of the metering system and assist with Business As Usual (BAU) activities.

Seqwater consultants and contractors may utilise this Guideline in delivering their scope per the gateway process or as otherwise directed by Seqwater.

Table 5 outlines how this Guideline can be applied to the gateway process.

No.	Gate	Application
0	Strategic Business Case	This Guideline can be used to ensure that desired project outcomes align with the energy strategy
1	Preliminary Business Case	This Guideline can be used to reference metering benefits and to categories, different types of metering required for each project
2	Detailed Business Case	This Guideline and the assessment tool can be used to justify the inclusion of meters in the project
3	Investment Decision	This Guideline can be used to develop specifications for the procurement of meters and monitoring systems
4	Readiness for Service	This Guideline can be used to support change requests during detailed design and implementation
5	Benefits Realisation	Performance measures considered within this Guideline support ongoing operations and benefits realisation

Table 5 Guideline application to the gateway process

This Guideline applies to three primary use cases:

- Seqwater assets that may benefit from metering
- Third-party assets within Seqwater premises that may require metering
- Embedded generation assets owned by Seqwater that may require metering

This Guideline applies to all new and existing assets and includes tools to assist in determining if the inclusion of a meter can be justified. This Guideline should be referred to when implementing any significant asset modification, replacement, or capital works project. It should be reviewed periodically on an ad-hoc basis to ensure that no opportunity is missed for a standalone improvement project.

5. Methodology

This section seeks to define a methodology for determining when and where a meter should be included in the planning, design and installation phase of an asset renewal or capital works project. The intent is to realise the benefits of increased visibility and granularity while avoiding an untargeted “scattergun” approach leading to excessive metering and unreasonable costs.

To ensure that Seqwater’s metering strategy has appropriate visibility and selectivity to use information effectively, it is essential to define specific areas within the site that may require metering. The term “logical area” is used throughout this Guideline to refer to these areas.

Logical areas for metering should encompass significant processes and critical functions of the plant. In this fashion, energy consumption data can be coupled with the process and operational data to develop meaningful EnPIs. EnPIs can then be used for baselining and tracking performance. They can also be used for benchmarking performance against similar equipment, plant and process areas, facilities, sites, or industry best practices.

Once logical areas that could benefit from monitoring have been identified, it is then necessary to determine if there is a sufficient benefit to justify installing a meter in that particular area.

5.1. General Principles

To devise a methodology to assist in determining where it is or is not beneficial to include a meter, it is helpful to understand the general principles guiding the exercise. These general principles are outlined as follows:

1. If the asset or process is a sufficiently large consumer of energy, it should be metered. As such, a method of determining a “minimum size” is required to qualify the system for metering.
2. As some assets and processes offer a higher potential for savings than others (due to different technologies and complexities), the qualification method must consider the relative probability for savings.
3. Some applications will have regulatory requirements for metering that must be adhered to regardless of other considerations for qualification.
4. The benefits of improved asset management and other non-energy efficiency-related benefits should be considered when assessing metering value.
5. Specific project details (primarily installation costs) may differ for greenfield vs. brownfield applications, considering the varying landscape for project execution.
6. The short term vs. long term benefits of metering should be considered when assessing the value of metering, with longer-term benefits being favoured.

5.2. Defining logical areas for metering

To achieve selective monitoring with adequate granularity, the metering system needs visibility to match the required system’s boundary.

If metering is installed at a level that is too high, the user will not have the required selectivity for monitoring specific processes or functions. If the meter is installed too low, the data will be unnecessarily granular, and the cost will be high. Having unnecessary meter data could also introduce complications with data management and storage.

When considering the electrical architecture of a site, the site can be separated into logical areas matching specific processes or functions. Several unique logical areas can be defined as listed in Table 6 and depicted in Figure 4 and Figure 5.

These logical areas can be divided into two distinct categories, Energy Metering and Submetering, each with specific purposes.

No.	Name	Example	Category
1	Individual assets	Pumps or an air compressor	Energy meter
2	Group of similar assets	A group of pumps, mixers, or agitators	Energy meter
3	Specific processes or systems	Ultraviolet (UV) treatment or chemical dosing	Energy meter
4	Ancillary circuits	Ancillary circuits, such as mechanical services or lighting	Energy meter
5	Third-party connections	A café or customer-owned pumps located on Seqwater's property	Submeter
6	Renewable connections	Behind the meter Solar or Hydro	Submeter
7	Subdivided sections	Subsections of a larger site that includes multiple, distinct facilities, e.g., Mt Crosby East Bank and West Bank	Energy meter

Table 6: Logical areas defined for this Guideline

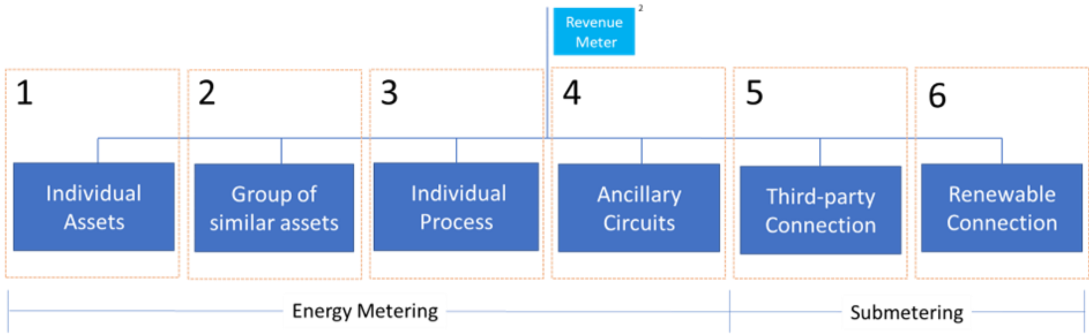


Figure 4: Logical areas for Metering (No. 1-6)

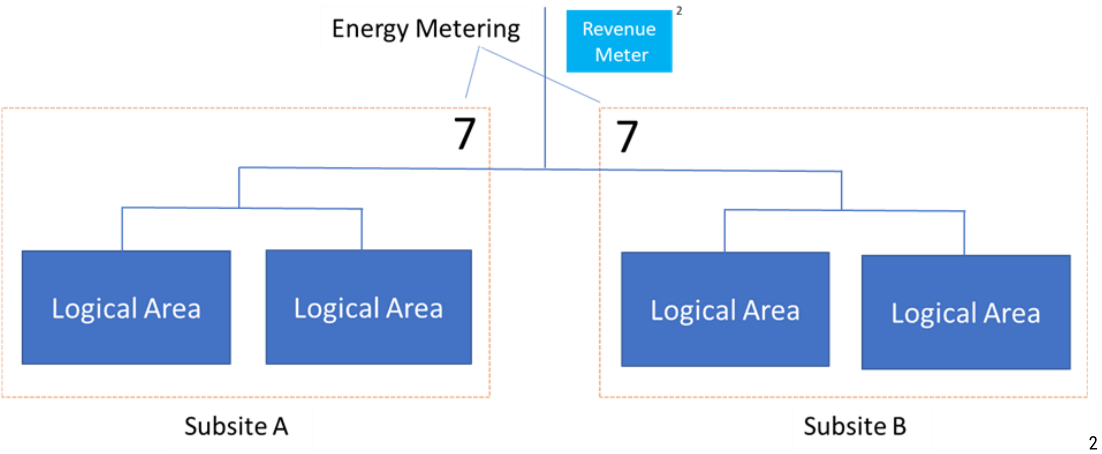


Figure 5: Subdivided sections of a larger site (logical area No.7)

Considerably large sites, such as a desalination plant would likely have multiple distinct sections. These could be considered subdivided sites for logical separation.

There may be cases where it is desirable to meter one logical area within a larger logical area. This situation could arise where an individual asset is contained within a related process, such as a pump feeding a filtration system. This situation is depicted in Figure 6.

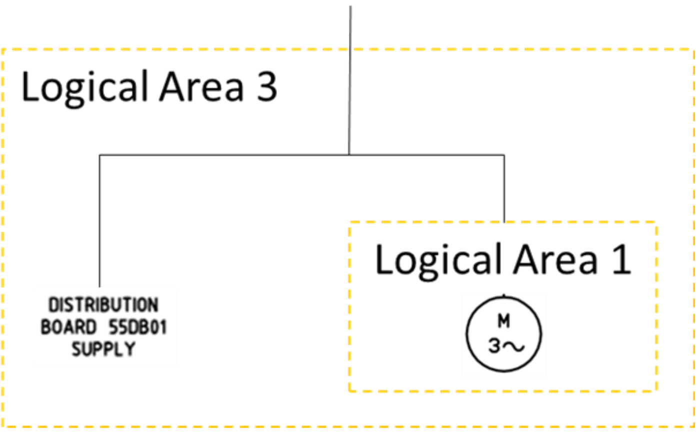


Figure 6: Example of one logical area (Individual Asset) within another (Individual Process)

There will naturally be significant overlap in this scenario and where there are subdivided sections (logical area No. 7). The overlap in both cases must be considered during the qualification and assessment. This scenario is discussed further in Section 6.1.5.

[2] Revenue Meters are installed and operated by accredited Metering Providers. They are used for billing the electrical consumption of the site and are not included in the scope of this guideline.

The logical separation of areas for metering can be applied for a greenfield installation at the preliminary design stage or applied retrospectively to brownfield situations.

Once the site loads have been assigned into logical areas, the next step is to determine if each logical area would benefit from metering.

5.3. Excluded areas

This Guideline does not apply to gas and water meters and does not apply to utility meters (revenue meters) installed at the network connection point.

5.4. Flow chart for meter identification and qualification

The general process for dividing a site into logical areas and then qualifying each area for metering is outlined in Figure 7.

By utilising this method, any Seqwater site can be methodically assessed to determine where additional metering may be required and if there exists a justifiable case to include one.

Area	Name	Area	Name
1	Individual assets	5	Third-party connections
2	Group of similar assets	6	Renewable connections
3	Specific process or systems	7	Subdivided sections
4	Auxiliary circuits		

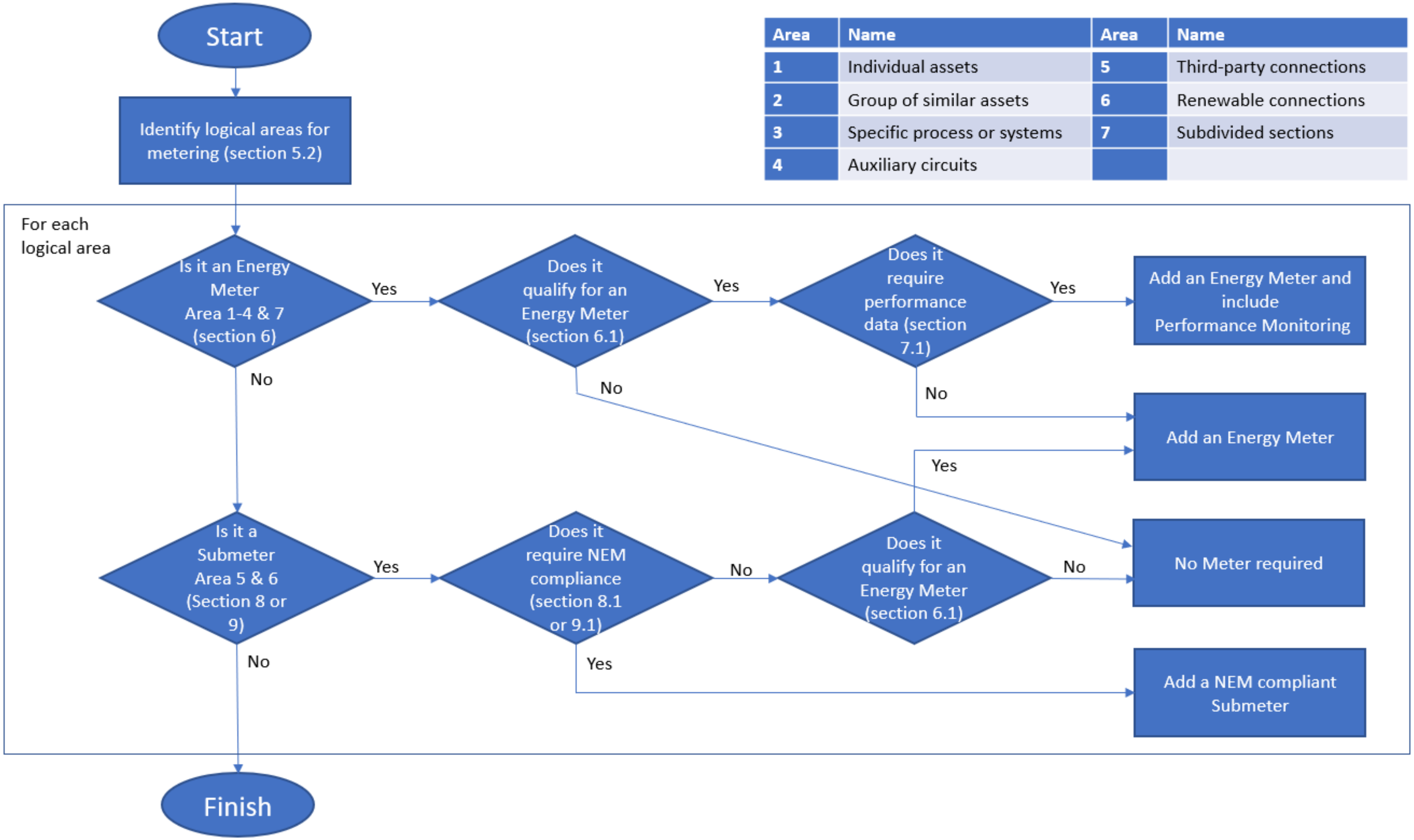


Figure 7: Process Flow

5.5. Assessing the need for Energy Metering and Submetering

Once the site has been assigned into logical areas for metering, it is then necessary to determine if each area would qualify for the addition of a meter or not. This qualification can be achieved through a benefits analysis by considering the cost of installing a meter at that location vs. the benefits that installing a meter would have.

Although each area from each site will be unique, there are general factors that can be used to determine if adding a meter is justifiable. These factors are different for Energy metering, Submetering and Performance metering.

For Energy metering (the first four logical areas defined in Section 5.2), the qualification will consider if the logical area exhibits Significant Energy Use (SEU). The standard ISO 50001 defines Significant Energy Use as "accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement". In line with this definition, the justification for these areas can be determined by considering the expected annual usage combined with the potential for that particular area to benefit from metering.

Specific cases for Energy metering and the justification for installing Energy meters are discussed in Section 6.

The qualification for submetering (logical areas No.5 and No.6) will depend on regulatory compliance. Compliance includes a need for transparent and accurate billing when on-selling energy to third parties and capturing accurate generation data when claiming large-scale renewable energy certificates. The decision to install a meter in these scenarios will be binary (yes or no based on compliance requirements). Outside of any regulatory requirements, the justification would revert to the Energy metering use case.

Specific cases for submetering and the qualification of logical areas for submetering are discussed in Section 0 and Section 9.

For subdivided sites or facilities (logical area No.7), although there are no regulatory requirements, the meters required will belong to the Submetering category. The qualification of these meters will be based on a need to understand the consumption of each sub facility independently.

While there will be considerable overlap between these areas and sub-areas, not all consumption within the facility is likely to be captured. The justification for metering must consider the balance of energy and the unique benefits of metering the area. Logical areas exhibiting overlap are discussed in Section 5.2.

5.6. Assessing the need for Performance Metering

Monitoring energy consumption alone may not be sufficient to understand if the system, process, or asset performs optimally.

To develop performance insights of a logical area, it is necessary to correlate energy, process and operational data. It is possible to combine site-level consumption data with site-level throughput data alone. However, this is not adequate. It is recommended to correlate area-specific energy, process and operational data (e.g., kWh as a function of pressure, water quality, flow, volume, weather, etc., individually or in combination).

The correlation between energy, process and operational data will result in bespoke EnPIs for a system, process, sub-process, facility or site as crucial metrics to baseline, monitor, benchmark, and validate against the objectives outlined in Section 4.2.

Additionally, AS/NZS 3598.2 defines EnPIs as a "quantitative value or measure of energy performance, as defined by the organisation". AS/NZS 3598.2 also defines the Energy Intensity (EI) as the "Ratio of energy consumption to a measure of the activity carried out by an entity". As such, both EnPIs and EI metrics can be defined as required by Seqwater to combine energy consumption data with the logical area's specific measure of production.

At the time of writing, most sites' Operational Technology (OT) systems are not collecting the energy data required for deriving EnPIs and EIs – mainly due to lack or absence of energy metering – usually, only the process and operational data is collected.

At Seqwater, EnPIs will be particularly relevant for pumps (refer to the Section 6.4 Energy Management System and Plan, PLN-00393) as efficient operation requires visibility of pressure and flow information. Other equipment such as blowers may have similar requirements.

Assessing the need for measuring performance information and justifying energy meter installations to include performance monitoring is explored further in Section 7.

5.7. Energy Efficiency Checklist

The Energy Efficiency Checklist in a separate document can be utilised alongside this Guideline. The checklist aligns with the Gateway Process and is used to highlight relevant items for consideration at each stage of the process concerning energy efficiency and metering. The checklist can be found at the REX link (D21/61966).

6. Energy Metering

For this Guideline, the term "Energy Meter" refers to any meter installed within Seqwater which has the primary purpose of measuring the energy consumption of an electrical asset. For this category of metering, there are no regulatory requirements.

As mentioned in the methodology section, the case for installing an energy meter will consider if the logical area exhibits Significant Energy Use (SEU). This definition considers both the expected annual usage of the asset or process combined with the potential to benefit from metering.

The expected annual usage of an area will depend on operational conditions, such as operating hours, duty cycle and load requirements. The potential for efficiency improvements will depend on the technologies present within the logical area and the application itself. This dependence is because some technologies can optimise, where other equipment may not require or facilitate performance tuning. The overall complexity of the application and the ability to enact operational changes can also lead to an increased potential for improvements.

Some logical areas are prone to performance degradation over time, where others have limited long-term benefits and may not require ongoing metering. An option for short term metering with temporarily installed portable devices is discussed in section 6.6.2.

6.1. Case for Energy Metering

The primary source of power monitoring savings will be reduced costs derived from the reduced energy consumption of a particular application through optimisation and improved management.

The Canadian Department of Natural Resources released a series of documents regarding Energy Management Information Systems (EMIS). One paper[3] notes that significant development work undertaken in the United

[3] "Energy Management for Information Systems, Achieving Improved Energy Efficiency" (REX document D21/67249)

Kingdom (UK) indicates that “when properly implemented, an EMIS can save 5 to 15 per cent of annual energy costs” and “as an initial approximation, 8 per cent appears to be a reasonable estimate”.

Although metering alone is not an EMIS, Metering is an enabler for implementing a well-functioning EMIS. As such, it follows that we can assume an annual reduction of energy consumption from installing a metering system.

As the attainable savings must justify the cost of both the metering system and the energy management system, a conservative portion of the estimated 8 per cent savings can be assumed.

From these energy savings, we can derive a quantitative assessment for the installation of a meter. To achieve this, we can apply a formula to determine the minimum load characteristics of an area such that the addition of a meter would meet specific investment criteria.

The required inputs for this assessment are:

- Total meter cost (including installation and integration)
- Required payback
- Cost of energy
- Expected savings
- Operational characteristics, such as duty cycle and load factor

The outputs from the assessment are (either) the minimum power ratings of an asset or the minimum nominal current ratings of an electrical circuit. These ratings can then be applied when reviewing design documentation, such as Single Line Diagrams (SLDs).

The formula for determining the minimum power and current is shown in Appendix A. A calculator has been developed to assist with applying this formula (Rex document D21/63060). Table 7 shows an example of the tool.

Asset, Process or Circuit	Pump
Include Performance Monitoring	no
Estimate Saving (%)	3
Total Metering Cost ($)	7,500
Duty Factor	0.8
Load Factor	0.75
Power Factor	0.9
Required Payback (Years)	5
Energy Cost ($/kWh)	0.12
Potential for savings	High
Consider performance monitoring	Yes
Minimum Power (kW*)	79
Minimum Current (A*)	120

Table 7: Tool example showing default input values

*Note that the outputs of the tool are the minimum *nominal* ratings of the load or circuit. Care must be taken when reviewing SLDs to ensure that these are not confused with maximum ratings. The current rating assumes a three-phase system and is the nominal rating per phase.

The qualification formula addresses differences in savings potential by applying specific assumed savings based on the logical area in question. The calculator utilises a drop-down box to select the particular application and applies the savings accordingly. The potential for savings is listed in Table 8.

The calculator tool and Table 8 also indicate if performance monitoring is likely to be required for the given application. This indication does not affect the calculation. As per the process defined in section 5.2, this formula should be used to justify energy metering for each of the identified logical areas in turn.

6.1.1. Default values

Table 8 includes default values that can be used when it is not practicable or possible to find the required inputs to the formula. This may be the case if the item of plant is small or the operating characteristics are unknown. The tool includes default values for each input as shown in Table 8. Where possible, defaults should be substituted for known values. For optimal results, all default values should be substituted with actuals. The default values can be reset at any time by using the “Reset Defaults” button in the tool.

Category	Asset, Process or Circuit	Potential for savings	Conservative Annual Saving	Consider Performance Monitoring	Default Power Minimum (kW)	Default Current Minimum (A)
Individual Asset	Pump	High	3%	Yes	79	127
	Blower	High	3%	Yes	79	127
	Air Compressor	High	3%	Yes	79	127
	Centrifuges	Medium	2%	Yes	119	191
	Conveyers	Medium	2%	No	119	191
	Cranes, Hoists and Winches	Low	1%	No	238	381
Grouped Assets	Mixers	Medium	2%	No	119	191
	Group of Pumps	High	3%	Yes	79	127
	Agitators	Medium	2%	No	119	191
Processes	Disinfection	Medium	2%	No	119	191
	UV treatment	Medium	2%	No	119	191
	Ozonation	Medium	2%	No	119	191
	Ozone generation	High	3%	Yes	79	127
	Chemical Dosing	Low	1%	No	238	381
	Dissolved Air Flotation	High	3%	Yes	79	127
	Filtration	High	3%	Yes	79	127
	Coagulation	Medium	2%	No	119	191
	Flocculation	Medium	2%	No	119	191
	Sedimentation	Medium	2%	No	119	191
	Clarification	Medium	2%	No	119	191
	Precipitative Softening	Low	1%	No	238	381
	Granular Activated Carbon Adsorption	Low	1%	No	238	381
	Biotreatment	High	3%	Yes	79	127
	Residuals handling	Low	1%	No	238	381
	Solids processing	Low	1%	No	238	381
	Adsorption	Low	1%	No	238	381
	Collection	Low	1%	No	238	381
	Effluent Transportation	Low	1%	No	238	381
	Fluoridation	Low	1%	No	238	381
	Neutralisation	Low	1%	No	238	381
	Oxidation	Low	1%	No	238	381
	Water Distribution	High	3%	Yes	79	127
	Site Services	Medium	2%	No	119	191
	Power Generation (Backup)	Low	1%	No	238	381

Category	Asset, Process or Circuit	Potential for savings	Conservative Annual Saving	Consider Performance Monitoring	Default Power Minimum (kW)	Default Current Minimum (A)
Common Circuits	General Site	Medium	2%	No	119	191
	Separation	High	3%	Yes	79	127
	Storage	Low	1%	No	238	381
	Light and Power	Medium	2%	No	119	191
	Mechanical Services (Inc. Lifts)	Medium	2%	No	119	191
	Control Power	Low	1%	No	238	381
	General Distribution	Low	1%	No	238	381
	Auxiliary Power	Low	1%	No	238	381
	Fire and Security	Low	1%	No	238	381

Table 8: Indicative potential for savings with default minimum values for power and current

6.1.2. Finding the required inputs

The inputs to the formula or calculator will depend on the logical area under consideration and other factors, including operational methodology and design factors. Table 9 provides an outline of the required inputs.

Formula Item	Note
Meter Cost	The meter cost can be taken from previous projects or recent quotations and shall include all costs required to install and integrate the meter.
Energy Cost	The cost of energy can be taken from historical energy usage, billing data or cost projections. It should be the "blended" peak/off-peak rate for kWh.
Annual savings	The expected annual savings will vary; however, a conservative amount may be assumed from previous experience with the asset type. Conservative savings used in the calculator are listed in Table 8.
Duty cycle	The duty cycle can be determined from the process methodology. The duty cycle shall be the average ongoing duty. For example, if the asset cycles on then off every hour on weekdays only, the duty cycle would be (12*5)/(24*7) = 0.357. If the asset is on continually, the duty cycle can be set to 1.
Load Factor	A load factor is included to account for differences between the nominal rating of an asset and the actual. For example, a motor may be designed to operate at around 75-80% of its rated load. If you use measured actuals (from an audit, for example), then the load factor can be set to 1.
Power Factor	If the power factor of the circuit is not known and the logical area is primarily driven by a motor (or a group of motors), the power factor should be set to 0.85. Otherwise, the power factor should be set to 0.9 or set to the measured power factor if known. Note that the power factor is often written on motor nameplates.

Table 9: Calculator Inputs

6.1.3. Using portable meters to assess parameters

For brownfield applications, it may be helpful to utilise a portable energy meter or data logger to assess the formula parameters. The mobile unit may be temporarily installed for one or two weeks and may be used to determine:

- Nominal current draw
- Duty cycles
- Power Factor

This approach may be preferable when assessing grouped assets with complicated operational parameters or processes where the nominal current draw is difficult to determine.

6.1.4. Using the outputs

The tool provides two outputs: the minimum power ratings of an asset or the minimum nominal current draw of a circuit. The minimum power rating can be applied when the power rating is known, for example, when considering a motor. The minimum current draw can be applied when considering a circuit. The nominal current draw of the circuit can be determined from design factors and operational methodology or by using a portable energy meter, as noted above.

6.1.5. Overlapping areas

For logical areas that exhibit overlap, including logical areas within logical areas and areas defined for subdivided sections (logical area 7), the overlap must be considered in the justification.

This can be addressed by reviewing the total cost of metering within the area against the total consumption. As shown in Section 5.2, Figure 6, the total consumption of the larger area can be compared against the cost of both meters. Another method is to consider the balance of the metered consumption vs. the cost of the overlapping meter.

Subdivided sections may offer unique metering benefits, including the accurate attribution of energy costs for each subsection.

6.1.6. Improving the business case with demand charges

In the context of metering, “Demand” is defined as the average power over an interval. Because Demand is calculated as an average, the measurement is not susceptible to spikes or dips as instantaneous power is. Maximum Demand is the maximum average power (Demand) observed over a given time.

Network utilities use Maximum Demand to record the maximum average power required to service the premises, which is used to calculate Network Demand charges. Networks Queensland utilises 30-minute intervals to calculate Demand, and the Maximum Demand is recorded, billed and reset each month.

At some Seqwater sites, network demand charges account for 40% of the site’s total electricity costs. Given the significance of these charges, it is essential to understand the contributing factors leading to Maximum Demand.

A significant benefit of increased metering selectivity is understanding which particular areas contribute to the maximum Demand.

Suppose a defined logical area has not qualified for energy metering, but metering may provide sufficient visibility to enable demand management. In that case, the opportunity should be assessed further to confirm if metering can be justified based on reduced demand charges.

As the interplay between usage and maximum Demand is site-specific and often complex, this assessment must be performed on a case-by-case basis.

6.1.7. Special circumstances

In some cases, although a logical area may not qualify for the addition of an energy meter as per the assessment formula, there may be other justifiable cases, including:

- A known demand reduction anticipated through improved demand management
- Quantifiable asset management benefits such as capital deferral or reduced maintenance costs
- Targeted emissions monitoring
- A recommendation from an energy audit
- Special requirements for a government-endorsed efficiency scheme[4]

An ad-hoc assessment can be made on a case-by-case basis to add a meter based on the specific merits of such an installation.

6.2. Energy Metering at Seqwater

Once logical areas for metering have been assigned, the following step is to qualify each area for metering using the formula or calculator in section 6.1. This section explores typical applications that can be found at Seqwater belonging to each logical area.

Where possible, asset descriptions used within this Guideline align with Seqwater's defined asset classes.

Individual Assets	Group of Similar Assets	Individual Processes	Ancillary Circuits
• Pumps • Blowers • Compressors • Centrifuges • Air Conditioners and Coolers (HVAC)	• Mixers • Small Pumps • Agitators	• UV treatment • Ozone generation • Dewatering • Chemical Dosing • Filtration • Flocculation and Clarification	• Light and Power • Mechanical Services • Control Power • General Distribution • Auxiliary Power • Fire and Security • Cranes, Hoists and Winches

Figure 8: Common Seqwater assets in each logical area

It should be noted that motors are not listed as specific assets; this is because motors seldom exist in isolation. Instead, they are used to drive one of the included assets, e.g., a pump or mixer.

[4] For example, improved metering for proof of achieved reductions for ACCU or similar scheme

6.2.1. Individual Loads

Seqwater has many assets that are large enough to justify individual metering. These assets are primarily large water pumps; however, Seqwater has large air compressors and other equipment that may qualify for individual metering. Some of the more prominent loads within this category are summarised in Table 10.

Asset	Summary
Pumps	Water pumps are driven by AC induction motors. Due to the complicated energy dynamics of pumping applications, pumps generally have a high potential for optimisation.
Motors	Induction motors are used to drive pumps, blowers, centrifuges, compressors, fans and other equipment. Due to the nature of induction motors and their application, induction motors generally have a high potential for energy savings.
HVAC Units	Although the load from Heating Ventilation and Cooling (HVAC) units is essentially from compressors and fans, HVAC units operate as an enclosed system and should be measured and optimised as a system. HVAC Units offer good potential for performance improvements.

Table 10: Individual loads

For pumps and motor-driven assets:

- The kW limit from the formula can be applied to the kW rating of the motor
- Some motors may use drives that may include Metering (Section 6.6.1)
- The power factor may be written on the motor nameplate
- Performance monitoring (Section 7) should be considered, particularly for pumps

For HVAC units:

- The kW limit from the formula can be applied to the electrical kW rating of the unit (not to be confused with the cooling capacity)
- Large HVAC units often support management tools that may include metering (Section 6.6.1)
- HVAC control systems often include performance metrics such as zone temperature and humidity. As such, performance monitoring (Section 7) should be considered
- If inverter-based, the power factor of the HVAC unit will be higher than a direct drive system

6.2.2. Grouped Assets

In cases where individual assets are not large enough to qualify on their own, they may qualify within a group of assets. Grouped assets include a collection of devices performing the same or similar function and are fed from the same electrical feed. Examples include a group of mixers or a collection of pumps operating in parallel.

Ideally, these assets will have a dedicated switchboard such as a motor control centre where a meter can be installed. Otherwise, it may be possible to install a meter to capture a segment of a bus servicing a group of equipment. Care must be taken to ensure that the physical arrangement of switchgear allows for this.

These arrangements are demonstrated in Figure 9, and example loads within this category are summarised in Table 11.

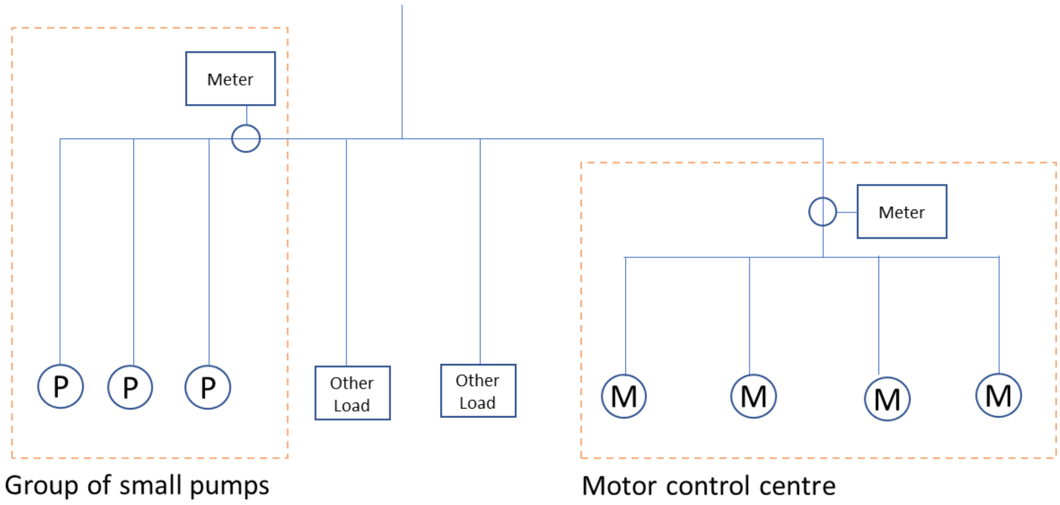


Figure 9: Example conceptual arrangement of grouped assets for metering

Process	Summary
A group of pumps	A group of pumps in parallel or a duty standby arrangement offer good potential for efficiency improvements from changes in operation and sequencing.
A group of Mixers or agitators	A group of mixes or agitators may offer efficiency improvements from changes in operation.

Table 11: Grouped assets

For groups of pumps, mixers, and agitators:

- The kW limit from the formula can be applied to the average kW rating of all motors that are running at any given time
- The duty factor will be the duty of the motors that are running
- The load factor will be the average load factor of each motor
- The power factor may be written on the motors' nameplates
- Performance monitoring (Section 7) should be considered for pumps

6.2.3. Specific Processes

Aligning logical areas to specific processes will promote selectivity of Metering at Seqwater. Some processes will be more conducive to energy efficiency measures than others, and some will naturally combine with associated production data. Some common functions within this category are summarised in Table 12.

Process	Summary
Ozone Generation	Ozone generation generally includes compressed air and can potentially offer efficiency improvements from changes in operation and design.
UV Treatment	Ultraviolet (UV) treatment generally involves electric lamps or bulbs and may offer efficiency improvements from changes in operation

Process	Summary
Chemical Dosing	Chemical dosing generally consists of pumps and mechanical dispensers, which are motor driven and can potentially offer efficiency improvements
Filtration	Filtration systems generally consist of pumps and air scourers; both are motor driven and may offer efficiency improvements through operational changes
Flocculation, Coagulation, Sedimentation, and Clarification	These processes generally consist of chemical dosing and skimming equipment; both are motor driven and can potentially offer efficiency improvements
DAF	DAF (Dissolved Air Flotation) plants generally consist of air compressors and skimmers; both are motor driven and can potentially offer efficiency improvements through design and operational changes
Aeration and Destratification	Aeration and Destratification generally consist of blowers or air compressors; both are motor driven and can potentially offer efficiency improvements through sequencing, operational changes, and design changes
Desalination or Separation	Desalination is an energy intensive process and can potentially offer efficiency improvements from changes in operation and design
Biotreatment	Biotreatment generally involves introducing oxygen into a bioactive “mixed liquor”. Large motor are used to driven air blowers, both may offer efficiency improvements through design and operational changes
Residuals Handling and Solids Processing	Residuals handling and solids processing generally include motor driven conveyers and may include a centrifuge for dewatering. Particularly in the case of a centrifuge, these processes may offer efficiency improvements through operational changes.

Table 12: Specific Processes

For all logical areas aligned with processes:

- The current limit from the formula can be applied to the current
- rating of the supply circuit
- The duty factor will be the operating duty of the plant
- The load factor will be the average load factor of the circuit
- The power factor will be the power factor of the circuit
- Performance monitoring (Section 7) should be considered where appropriate

6.2.4. Ancillary Circuits

The electrical infrastructure at Seqwater can be separated into logical areas by circuit type. Circuit types are often defined by the main class of load being supplied by the switchboard and are often labelled on the SLDs.

Process	Qualification and tool application
Mechanical Services	Mechanical services within Seqwater generally consist of HVAC but can also include fire services and lifts. HVAC is a good area for improvement (see individual loads above). Other mechanical services offer limited efficiency improvements from metering
Light and Power	Although energy efficiency can be achieved by updating lighting to newer technologies, there are little ongoing benefit from metering these circuits
Control Power	Control power generally consists of creating and distributing a DC (Direct Current) supply for control and instrumentation equipment. Few benefits can be gained metering from these circuits
General Distribution	General Distribution consists of Light and Power, and other circuits. Few benefits can be gained metering from these circuits

Table 13: Circuit Types

For all logical areas aligned with these ancillary circuits:

- The current limit from the formula can be applied to the current rating of the circuit
- The duty factor will be the operating duty of the circuit
- The load factor will be the average load factor of the circuit
- The power factor will be the power factor of the circuit

6.2.5. Metering medium voltage assets

Seqwater has several larger pumps that have Medium Voltage (MV) supplies. Due to the size of these assets, they would likely be identified as individual assets as per section 6.2.1.

Metering these assets introduces additional cost and complexity in the metering design. In most cases, these circuits would include protection and control equipment. Depending on the equipment used, it may be possible to utilise this for metering, as discussed in section 6.6.1.

The justification for MV assets will be as per the assessment formula considering the unique costs of MV metering.

6.3. Quantitates and Accuracies

For energy metering applications, the meters must record energy consumption in periodic intervals. This method will allow for the development of profiles over time for regression testing and predictive analytics.

The meter must capture both active and reactive power and must record energy consumption (or generation) in all directions.

For energy profiling, the meter must capture:

- kWh Import
- kWh Export
- kvarh Leading
- kvarh Lagging

These quantities may originate from the meter as either total accumulation values, interval-based accumulation values or block demand values[5] , depending on the data capture method used and overall architecture. Meter data captured methods are discussed in section 10.

The meters may also capture general purpose data to populate energy dashboards or a Human Machine Interfaces (HMI) to drive energy awareness, assist with operations, and identify localised issues. Data may also be logged to a historian and used for planning and analysis. These values would be captured from the meter as instantaneous values.

For general purpose use, the meters shall capture:

- Voltage L-L, L-N & 3P Avg L-N
- Current per phase & 3P Avg
- Active Power
- Apparent Power
- Reactive Power
- Power Factor
- Frequency
- THD for Voltage and Current per phase

Unlike energy values, these would be instantaneous quantities captured from the meters in near real-time.

The Maximum Demand that NSPs bill for is calculated from energy data and can also be calculated by Seqwater. If an alternative implementation of Maximum Demand is required for operational purposes, the meter must support and be configured to capture this measure accordingly.

As the meters required for Energy Metering are not being used for billing, they do not need to confirm to Chapter 7 of the National Electricity Rules (NER). The Water Services Association of Australia's (WSAA) Supervisory Control And Data Acquisition (SCADA) guideline states that instruments (including meters) should "*measure a process variable with the accuracy and resolution required for satisfactory process control and monitoring."*

In line with the WSAA guideline, values for general display and indication may be implemented with lower accuracy; however, for performing energy analytics, regression testing, and building meaningful baselines and models, energy data must be suitably accurate.

For energy metering, a minimum level of accuracy is defined as follows:

- Active Energy to IEC 62053-21 Class 1
- Reactive Energy to IEC 62053-23 Class 2

6.4. Data Capture and Storage

As the meters required for energy metering are not being used for billing, they do not need to comply with Chapter 7 of the NER, and as such, there are no regulatory requirements for data capture and storage.

The SCADA WSAA guide notes that "An assessment shall be performed by the Water Agency on the required frequency of transmission and historian updates."

[5]Demand can be translated to energy by multiplying the demand value by the interval period.

To align energy meter data with site-level billing data, the capture frequency shall be equal to or higher than the market settlement period. Currently, this is five minutes. As such, all meters installed for energy metering at Seqwater shall be capable of recording data in five-minute intervals.

Although there are no regulatory requirements to store data locally on the meter, this option may be preferable. An assessment shall be made to determine the most appropriate method with consideration of the overall OT architecture. General methods for data capture and storage are explored in Section 10.

6.5. Communications

All energy meters must include a connection to Seqwater's control network. Seqwater standard SPE-00361 describes the communication requirements for Seqwater's networks and defines compliant options for physical devices, available protocols and security. Seqwater standard SPE-00358 defines Seqwater's system architecture.

It is expected that meters would be installed adjacent to control equipment within a "process group" defined by SPE-00358. Meters with serial ports can connect to terminal units connected to the Field Remote In Out (RIO) Local Area Network (LAN), whereas meters with ethernet ports can connect directly to a switch on the Field RIO LAN. There is a strong preference for meters to include an ethernet port.

Notionally, the meter would utilise an approved protocol to interface with the local control system. An assessment shall be made to determine the most appropriate protocol to use. The meter read methodology, discussed in Section 10, may influence the communication method.

If the meter is required to be installed remotely and there is no existing control infrastructure, remote telemetry may be necessary. Remote telemetry for metering must comply with the requirements defined in SPE-00361.

All energy meters interfacing with Seqwater's OT network must comply with the security requirements defined in SPE-00361.

6.6. Energy meter data for other sources

There are several devices other than energy meters that may be utilised to capture energy meter data.

6.6.1. Intelligent Energy Devices

Within Seqwater's electrical distribution network, there are electrical protection and control devices that capture metering data. In some circumstances, this data may be adequate for Seqwater's energy metering requirements. Where available, utilising data from these devices could negate the need for energy meters, which would improve the business case for energy metering at that location.

Several devices installed within Seqwater that may include metering data include:

- Revenue Meters
- Panel Meters
- HVAC Systems
- Solar Inverters
- Variable Frequency Drives
- Soft Starters
- Protection Relays
- Circuit Breakers
- Motor Control Centres
- Universal Power Supplies

If these devices are installed on a circuit or asset that could require monitoring, it may be possible to utilise these devices in place of installing an energy meter.

With the exception of panel meters and revenue meters, it is likely that these devices will not have all the features and functions of a regular meter. However, if these devices meet the requirements listed in section 6.3, it may be possible to utilise these devices for energy metering. If the device does not meet the requirement of section 6.3, then an assessment shall be made to determine if a dispensation can be accepted.

Suppose the logical area would not qualify for the addition of a meter, but metering data is available from an installed device. In that situation, there may be a case to capture data from the installed device instead.

Additional costs (if any) of integrating metering data from an alternative source must be considered in the assessment.

If a basic panel meter exits in the proposed metering location, it may be prudent to replace the basic meter with a compliant energy meter. The installation cost may be less if CTs, meter enclosures or other components are reused.

Revenue meters are installed and maintained by a Metering Provider. Although these meters are outside of the scope of this guideline they may be utilise for metering where available. Data capture methods from these meters is discussed in Section 10.3.

Some devices within Seqwater might also include performance information as per Section 7. For example, some HVAC control units may include temperature and airflow data.

6.6.2. Portable meters

There may be a need to meter power temporarily. This requirement could arise when an asset or process does not qualify for metering as per Section 6.1 but may still benefit from metering temporarily.

Several reasons for temporary metering with a portable energy meter include:

- Confirmation of an efficiency upgrade that may not have ongoing benefits
- Investigation of an energy performance issue that requires highly granular data
- Auditing a logical area to uncover the operational details needed to assess metering
- Analysis of power quality issues

Figure 10 shows a typical portable energy meter.

Figure 10: A portable Energy Meter

6.6.3. Virtual meters

Although virtual meters are not devices, virtual metering is a method that can be used to aggregate data from multiple meters into one larger area.

This method can be used to meter an area that comprises multiple logical areas, such as a process where meters exist on several assets within. This situation is similar to one outlined in Section 5.2, Figure 6. One difference is that residual usage may be present if some loads within the area had been too small to justify metering on their own.

7. Energy Performance Monitoring

Energy metering alone may be insufficient to capture meaningful insights regarding how an asset or system is performing. For this reason, it may be necessary to measure additional quantities that can be used in conjunction with energy data to provide a holistic view of how the asset or system is utilising energy in consideration of its intended output.

Performance data can then be used to develop EnPIs and EI metrics and can be used for asset management and planning, among other benefits.

The measurement of additional quantities for performance monitoring may be required for logical areas that are (in general) complex, critical, throughput orientated systems with measurable outputs.

Within the water industry, performance monitoring is beneficial for pumps. However, applications, such as ozone production and compressed air systems, such as scrubbers and DAF systems, may also benefit from performance monitoring, among others.

Some logical areas may not require (or be suitable for) performance monitoring as they do not have a measurable output or the output is mainly inconsequential, such as lighting or ancillary services.

Given that energy data is required to generate EnPIs and EI metrics, performance monitoring would only be included where an energy meter exists. As outlined in Section 5.4, Figure 7, logical areas must qualify for energy metering before additional performance monitoring is required.

7.1. Case for energy performance monitoring

The case for energy performance monitoring will be similar to the case for energy metering, where savings discovered from improved visibility can justify the cost of performance monitoring.

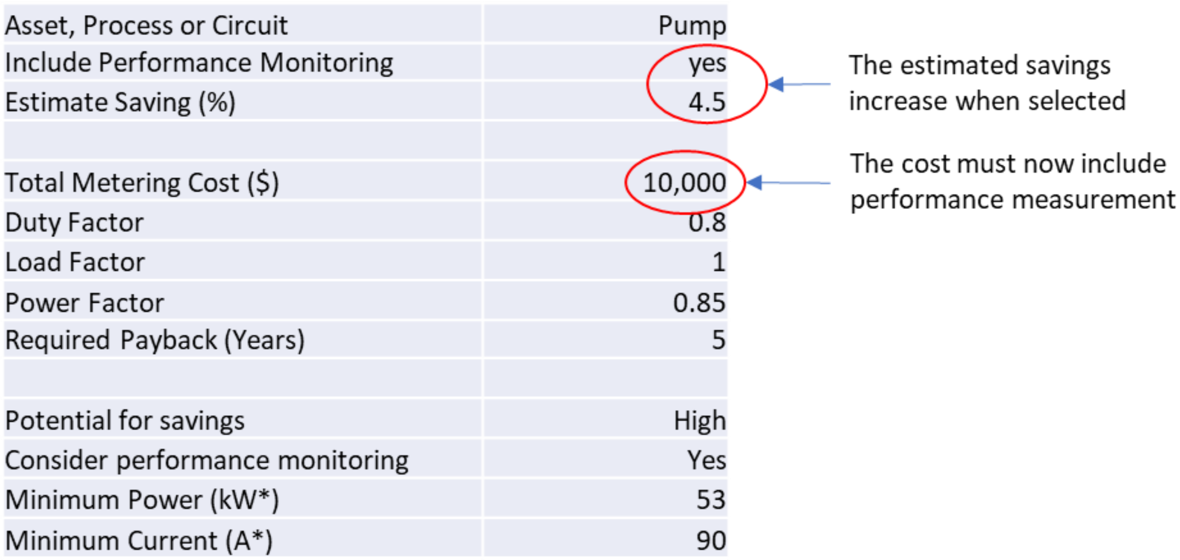
In addition to improved visibility of how an asset is utilising energy, performance monitoring is beneficial for asset management. Performance monitoring can allow asset managers to profile the performance of an asset over time and use this information to make an informed decision about maintenance scheduling and asset planning.

Improved maintenance scheduling can lead to cost savings by reducing or eliminating the need for periodic maintenance as performance data can be used to assess conditions continuously and remotely. Cost benefits can also arise from capital deferral, where the life of an asset can be extended closer to the limit of its usable life as opposed to a more conservative period-based replacement scheme.

Considering the additional benefits of increased visibility and improved asset management, it is estimated that the inclusion of performance measurements with energy metering would increase the expected annual savings by half of what could be expected from energy monitoring alone.

For performance monitoring, the formula or calculator for energy metering can be reused. Given the additional cost of the performance measurement instruments, the "Total Metering Cost" must increase. Similarly, the anticipated annual benefits can increase.

As mentioned, the estimated savings can be increased from the estimated savings from energy metering alone (listed in Table 8). The calculator automatically adds another half of the estimated savings from energy metering when "Include Performance Monitoring" is selected.



Asset, Process or Circuit	Pump
Include Performance Monitoring	yes
Estimate Saving (%)	4.5
Total Metering Cost ($)	10,000
Duty Factor	0.8
Load Factor	1
Power Factor	0.85
Required Payback (Years)	5
Potential for savings	High
Consider performance monitoring	Yes
Minimum Power (kW*)	53
Minimum Current (A*)	90

Figure 11: Using the tool to assess performance monitoring

As outlined in the process diagram in Section 5.4, the logical area must first be qualified for energy metering. If the area does not qualify for energy metering, it is unnecessary to consider energy-related performance monitoring.

If the area qualifies for energy metering, it may also benefit from performance monitoring, and the installation of performance monitoring equipment can be justified utilising the assessment tool as above.

7.2. Performance monitoring at Seqwater

Seqwater has many assets that could benefit from performance monitoring. The development of EnPIs will drive the need for performance monitoring in any given area. An assessment shall be made to determine the required EnPIs as part of Seqwater's energy efficiency framework.

Considering the cost and complexity of adding performance monitoring to plant, the prospective items will generally be significant energy users that offer ongoing benefits from performance and asset management.

The primary need for performance monitoring at Seqwater will be for pumps. Performance monitoring of pumps, in particular, has considerable benefits for both asset optimisation and management. Pumps have efficiency profiles that determine how effectively the pump can convert electrical energy into hydraulic energy. Pumps also experience wear which affects the performance of the pump over time.

The document "Efficiency Guideline for pumping applications" (D21/43463 in progress) has additional information about performance measurements for pumps and utilising these measurements for optimising pump efficiency.

As discussed in the previous section, the calculator can be applied to quantify if the pump is large enough to justify the addition of both energy metering and performance monitoring.

7.3. Quantities and Accuracies

The quantities and level of accuracy required will depend on the specific performance metrics captured. Two commonly adopted performance metrics for pumps are kWh/ML/m and kWh/ML.

In addition to energy consumption, a continuous measure of flow and system head is required to formulate these metrics. To calculate the quantities required, it may be necessary to measure:

- Suction and discharge pressure
- Inlet and outlet temperature
- Flowrate
- Fluid levels

Not all of these measures are required, as some can be derived from others. Some of these measures may already be available in SCADA.

The particular requirements will be application-specific, and for each case, an assessment shall be made with consideration of the cost of each option to determine the most appropriate solution.

The WSAA SCADA guideline states that instruments should "*measure a process variable with the accuracy and resolution required for satisfactory process control and monitoring.*". In line with this guidance, the accuracy and resolution of the measurement instruments shall be sufficient to enable satisfactory generation of the performance metrics required.

7.4. Data Capture and Storage

The requirements for data capture will largely depend on the performance metric in question and the prerequisites for meaningful information to be obtained.

At a minimum, it is anticipated that the data capture frequency would match the capture frequency of the corresponding energy meter. There may be a need to increase the capture frequency of the energy meter to match the frequency required for adequate performance monitoring.

There are no requirements for local data storage of the performance measures.

7.5. Communications

All instruments utilised for energy performance monitoring will be connected to Seqwater's OT architecture. The communication requirements for measurement instruments shall be as per SPD013.

Instruments will likely connect to a nearby RIO device, depending on the overall architecture. An assessment shall be made to determine the most appropriate communication method.

8. Submetering – Third Parties

For this Guideline, a Submeter is any energy meter within Seqwater used to capture consumption data for billing or capture production data for clean energy certificate generation.

If a third-party entity consumes electricity from within another entities' premises, the electrical infrastructure utilised to supply the third party becomes an "Embedded Network". An example of this is an airport or shopping centre where retail outlets consume electricity from the premises.

Individually Submetering the third-party's electricity connection enables the embedded network owner to facilitate the sale of energy to the third party.

8.1. Case for Third-Party Metering

As a result of the "Power of Choice" reforms, from 1 December 2017 in Queensland, every customer within an embedded network has the right to purchase electricity from a retailer or continue to purchase electricity from the owner of the embedded network.

Should they choose to purchase electricity from a retailer, the meter must be NEM compliant. It must also be registered with the NEM as having a logical connection to the market.

This arrangement is known as an "on market child connection".

If the consumer does not choose to purchase electricity from a retailer, the meter used to measure consumption is known as an "off-market child connection".

Figure 12 outlines the structure of an embedded network, including both on-market and off-market connections. Further details regarding the structure of embedded networks can be found in the Australian Energy Market Operator (AEMO) document "Embedded Networks – Detailed Market Design".

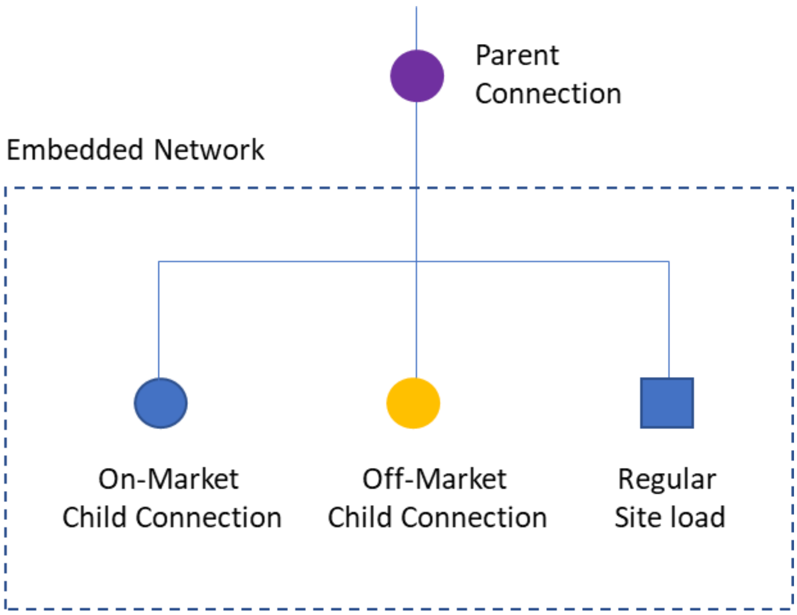


Figure 12: Structure of an Embedded Network

By law, a person selling electricity would typically require a retail licence; however, exemptions apply when the sale of electricity is incidental to general operations. In some situations, a person on-selling electricity may be “deemed exempt” from requiring a licence; in other cases, an exemption must be granted. Similarly, a person operating an electrical network would normally require a Network Services Provider (NSP) licence; however, exemptions apply for this also.

For any third-party customer that elects to use an electricity retailer of their choice, the connection must be metered, and the meter must be NEM compliant. The third parties’ Metering Provider would typically install and manage their own meter for these cases. If a third-party customer has not chosen a specific retailer and intends to purchase electricity from the embedded network owner, the connection must also be metered.

Although meters utilised for private billing are not necessarily required to be NEM compliant, “off-market meters” used for this purpose must provide an *equivalent* level of accuracy to facilitate billing consistent with what would have been billed had the third party been connected to the network directly. Due to this requirement, the meters must effectively be NEM compliant.

There are also legal obligations governing the billing process, including providing services such as payment options and hardship facilities.

8.2. Third-Party connections at Seqwater

In the case of Seqwater, where there exists a private Café or a customer-owned pump station located on Seqwater’s premises, The Café or pump station becomes a child connection within an embedded network owned by Seqwater.

At this moment, there are no “on-market” third-party consumers within Seqwater. There are, however, customers that consume electricity from Seqwater in an “off-market” arrangement.

Figure 13 outlines the third-party connections at Seqwater.

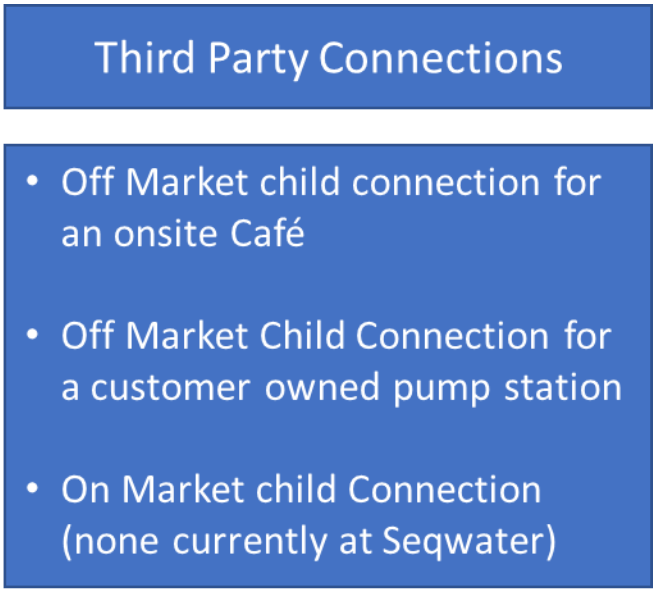


Figure 13: Types of embedded connections at Seqwater (or expected)

Suppose a third-party consumer elects to utilise a retailer of their choice. In that case, it is expected that the meter would be replaced by a Metering Provider (MP) as the MP would generally provide, install, and maintain their meters as part of their services to the appointed Metering Coordinator (MC).

For off-market child connections within Seqwater, it may be prudent for Seqwater to engage an accredited MC to ensure that appropriate metering services are provisioned for billing. This approach would mitigate the risk of Seqwater not fulfilling its obligations for compliant metering.

Appendix C outlines the process for appointing an MC. Although this process is designed for on-market Metering, MCs can be engaged for off-market submetering also.

It is also possible to engage the services of a billing provider to ensure that compliant billing services are available to the embedded customer.

Regarding obtaining exemptions for both the sale of electricity and the distribution of electricity within Seqwater's embedded networks, an assessment shall be made to determine the exemption requirements for all submetering scenarios. Any required exemptions must be obtained before the commencement of providing electricity to the third party.

It should be noted that for both situations, on-market and off-market, the network charges levied for supplying electricity to Seqwater's embedded network are charged to Seqwater regardless of who is consuming energy within the embedded network.

The "Electricity NSP registration exemption guideline" states that external network charges can be apportioned to each customer on a 'caused pays' basis or determined on a 'shadow price' basis.

8.3. Quantities and Accuracy

The "Australian Energy Regulator (AER) Retail Exempt Selling Guideline" states that "An exempt person must not charge the exempt customer tariffs higher than the standing offer price". Due to this requirement, off-market child meters must provide an equivalent level of accuracy to on-market meters. As such, all meters used for third party billing at Seqwater shall be NEM compliant meters.

The required accuracies and quantities for NEM compliant meters are defined by Chapter 7 of the National Electricity Rules (NER) and the National Metrology Procedure (NMP). As per the rules, a specific metering "installation type" is required. The installation type determines various parameters, including the required quantities and accuracies.

The installation type required depends on the expected annual volume at the connection point. Metering types are outlined in

Appendix B.

8.4. Data Capture and Storage

For both on-market and off-market meters, the capture frequency must be equal to or higher than the market settlement period. Currently, this is five minutes. As such, all meters installed for energy metering at Seqwater shall be capable of recording data in five-minute intervals.

As per the metrology procedure, meters must have the capability to store the data locally for a minimum of 35 days. To ensure data consistency and comply with the requirement to store data in the meter, it may be necessary to implement a block data reading method[6]. For convenience and to ensure compliance with Chapter 7 of the NER, it may be preferable to utilise the services of an accredited MP and Meter Data Provided (MDP) for all "off-market meters".

8.5. Communications

The communication requirements for submetering will depend on the type of market connection. For "on market" connections, the appointed MC would be responsible for provisioning the installation of a compliant meter, including the required remote communications via a public carrier.

Notwithstanding the requirements for local data storage, off-market meters can connect to Seqwater's OT infrastructure per the energy meter requirements in Section 6.5.

9. Submetering – Embedded Generation

Embedded generation is generally defined as any generation facility connected to an electricity consumer's infrastructure downstream of the network connection point. It is often referred to as "Behind the Meter" generation as it is situated behind the revenue meter installed at the network connection point.

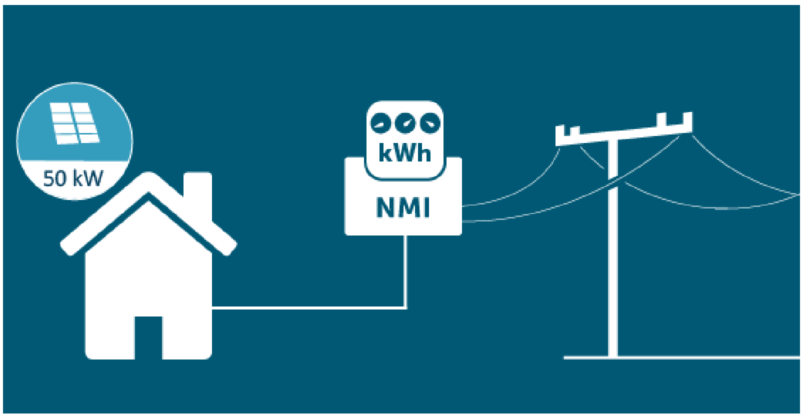


Figure 14: Example of embedded or "Behind the Meter" solar[7]

[6] General reading methods are outlined in Section 10.
[7] Picture from http://www.cleanenergyregulator.gov.au/

Submetering for embedded generation is generally used to enable visibility of how a generation asset is producing energy. Another driver for submetering a generation asset is to capture production data to generate clean energy certificates.

9.1. Case for Submetering Embedded Generation

As mentioned in Section 4.3, benefits for metering embedded generation include improved awareness of how generation assets are performing. This information can be used for confirmation of investment criteria, revenue forecasting and alike.

Submetering a generation asset also allows for the gross generation of the asset to be captured. Where a single site meter is installed, only the net consumption of the site can be observed. The details of what was generated vs. what was consumed cannot be determined without metering the generation independently.

The primary driver for installing a meter is typically to create Large Scale Generation Certificates (LGCs). These certificates represent an essential revenue stream in the business case for installing embedded generation.

LGCs can be created for eligible power stations as determined by the Renewable Energy Act (REA). LGCs currently apply to solar installations >100kW, hydroelectric generators >6.4kW and other forms of eligible generation.

To create LGCs, energy production data from the embedded generator must be submitted to the Clean Energy Regulator (CER). Meters used to capture this data must meet the Large-Scale Generation Certificates (LGC) eligibility requirements as specified under the REA.

The Act specifies that meters used for this purpose must be in accordance with Chapter 7 of the NER. A guideline detailing the requirements for LGC creation can be found here.

If the embedded generation facility is not eligible for creating LGCs, it may be suitable for generating Small-Scale Technology Certificates (STCs). STCs are allocated based on the *expected* production over a deemed period and do not require metering.

9.2. Embedded Generation at Seqwater

Embedded generation at Seqwater currently consists of Solar Photovoltaic (PV), Hydroelectric generation and backup diesel generation. These forms of embedded generation are depicted in Figure 15.

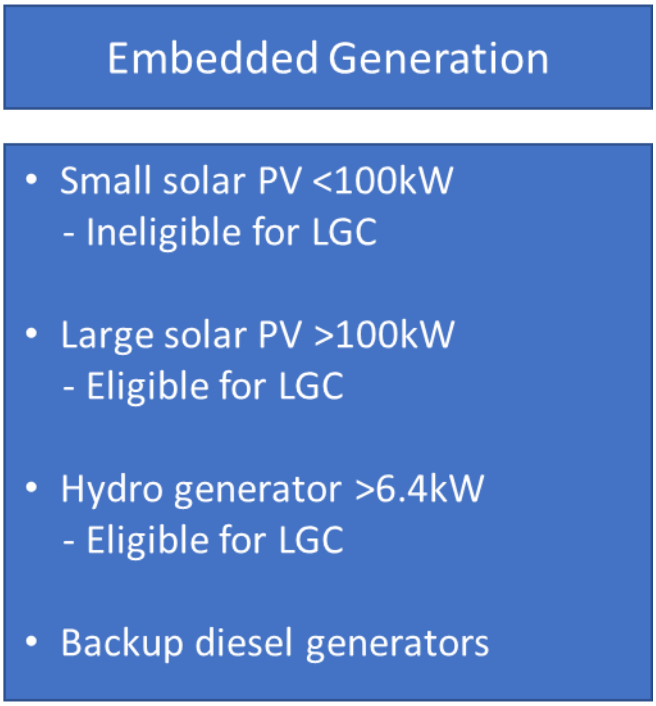


Figure 15: Embedded generation at Seqwater (or expected).

All embedded generation eligible for LGCs must include a NEM compliant meter to generate LGCs. As such, all solar installations >100kW at Seqwater must include a NEM compliant meter, as do any hydroelectric generators >6.4kW.

According to the NER, the type of metering installation required is determined by the annual volume expected at the connection point.

Appendix B summarises metering installation types, including the annual volume thresholds and required accuracies. The boundary threshold between a Type 3 and Type 4 installation is 750MWh/an.

For Solar, this annual volume translates to a system size of approximately 0.5MW[8]. As such, for solar installations less than 0.5MW, a Type 4 metering installation would be required. For larger systems (up to approximately 65MW), a Type 3 installation would be necessary. Note however, that these thresholds (0.5MW and 65MW) are provided as a guide only. Detailed engineering design is required to determine the appropriate installation type.

For hydroelectric generators, the metering type required also depends on the expected annual generation of the plant. Unlike solar, however, the yearly production is entirely dependent on operational methodology.

For the embedded generation that is ineligible for LGC creation, three are no regulatory requirements for metering. In this case, a meter capable of capturing gross generation data to improve visibility is sufficient. For this purpose, an energy meter as specified under this Guideline will suffice.

For solar generation systems ineligible for LGCs but greater than 30kW[9] at the inverter, a energy meter should be included with the installation. It may be possible for systems smaller than 30kW to utilise metering data from the inverter as grid-connected inverters generally have metering data. Section 6.6 includes information on using other devices for metering.

As all hydroelectric generators at Seqwater will be larger than 6.4kW, all will be eligible for LGCs. The backup diesel generators at Seqwater are used temporarily and, as such, do not require metering.

9.3. Quantities and Accuracies

For embedded generation eligible for LGCs, the meter must be NEM compliant. As such, the quantities and accuracies required shall be as per the meter installation type outlined in

[8] In South East Queensland, a 1kW solar system produces on average approx. 4.2kWh per day

[9] This threshold is generally used by Networks Queensland to impose additional controls

Appendix B. For convenience and to ensure compliance with Chapter 7 of the NER, it may be preferable to engage an accredited MC to provide metering services.

Appendix C outlines the process for appointing an MC. Although this process is designed for on-market Metering, MCs can be engaged for submetering also.

For embedded generation ineligible for LGCs, the quantities and accuracies required will be as per the energy metering requirements detailed in Section 6.3.

9.4. Data Capture and Storage

As all meters used for eligible embedded generation must be NEM compliant, data capture and storage requirements will be as per Chapter 7 of the rules, including the requirement to store interval data within the meter for 35 days. For convenience and to ensure compliance with the rules, it may be preferable to engage an accredited MC to provide metering services.

Appendix C outlines the process for appointing an MC. Although this process is designed for on-market Metering, MCs can be engaged for submetering also.

For embedded generation ineligible for LGCs, data capture and storage requirements will be as per the energy metering requirements detailed in Section 6.

9.5. Communications

To generate LGCs, energy production data must be submitted to the CER. These submissions are generally lodged periodically by uploading a file to the registry portal. As such, the is no specific requirement for a communication channel from the meter to the CER. There remains a requirement for data to be retrieved “remotely” via Seqwater’s OT architecture or transferred from the MDP where utilised.

For embedded generation ineligible for LGCs, the communication requirement shall be as per the energy metering requirements detailed in Section 6.5.

10. Data Logging and Profiling

To perform energy analytics within the EMaAP, the metering system must capture and profile data at the desired frequency over time.

How the data is managed within the historian or data warehouse is outside the scope of this Guideline. However, how the information is captured and transferred to upstream systems is a question for the meter and metering architecture.

10.1. Meter Reading Methods

There are two common methods for capturing energy data for an EMIS within an industrial context. One method requires the meter to support short term data logging while the other does not. There are pros and cons to both methods referred to herein as “Method A” and Method B.

Method A is the simpler of the two. This method involves capturing the measurements in a short-term data register. An upstream system then reads the register at a frequency equal to the capture frequency. The data is then added to a historic data profile within the EMIS or historian. This method does not require onboard meter data storage and can be implemented with any SCADA system that supports standard register-based protocols such as Modbus.

Method B is more complicated. The meter keeps a data log for this method, sometimes referred to as a "load profile" within the meter with several days' worth of storage. The data profile is then transferred to upstream systems, typically daily, using a dedicated meter data reading protocol. The data is generally collected by a purpose-built Meter Data Head End (MDHE), which can then pipe the data into the EMIS or data warehouse.

Method A and Method B are depicted in Figure 16.

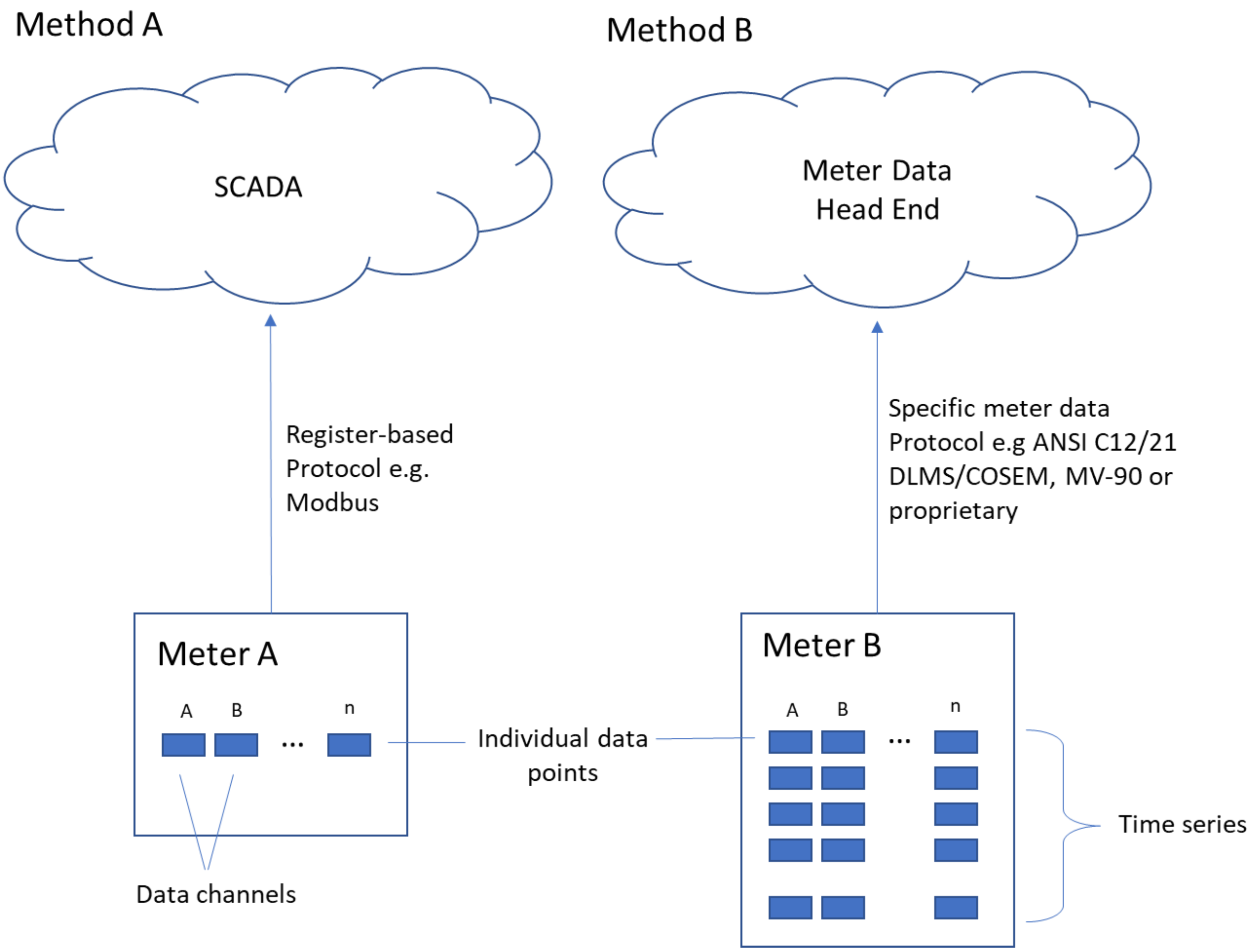


Figure 16: Methods for meter data capture

The pros and cons for the two different reading methods are outlined in Table 14.

	Pros	Cons
Method A	• Basic architecture • Consistent with current design • Common, standard and familiar protocols • No MDHE required • Cheap meters	• Need to read total accumulation data or block Demand then convert (Section 10.2) • Read timing is important • Momentary communication loss leads to data loss • Frequent reads required

Method B	• Read timing is flexible • Can read interval energy data directly • MDHE manages read scheduling • Infrequent reads required	• Meters are more expensive • Ongoing costs for the MDHE • MDHE adds another layer to Seqwater's architecture • May still need to read instantaneous data (via register reads) for dashboards

Table 14: The pros and cons of reading methods A and B

Method B is used exclusively by accredited metering providers as it provided a robust metering solution suitable for regulatory compliant metering installations. This method should be utilised by Seqwater, where NEM compliant metering is required or inferred through other regulatory requirements. Where Method B is needed, it may be preferable to use the services of an accredited Metering Provider to ensure compliance.

Method A is adequate for all energy metering applications, and as there are no regulatory requirements for performance monitoring, method A is suitable for performance monitoring.

An assessment shall be made to determine the most appropriate method to use for the specific metering application.

10.2. Converting meter data into interval-based energy data

The data warehouse needs to record interval-based energy accumulation data to develop trends over time for regression testing and predictive analytics.

Considering available quantities within a typical electricity meter, it may be necessary for OT systems to convert raw meter reads into interval-based energy values.

Electricity meters typically provide:

- Total accumulation values for energy
- Block demand values
- Instantaneous power values

These values are available to be read directly from the meter using read method A. Total accumulation values for energy can be converted into interval-based values by subtracting the n^{th} read from the $(n-1)^{th}$ read and logging the difference accordingly. Block demand values can be converted into interval-based values by multiplying the demand value by the interval period.

These conversions could occur at several locations within the OT architecture. The optimal location shall be determined during the detailed design phase. Care must be taken to ensure that data is captured at the right moment and to ensure that the calculated parcel of energy is logged to the correct period within the data warehouse.

For profiling energy, it is important that instantaneous power values are not used. This is because converting instantaneous power values into energy values does not result in a true representation of energy consumption.

Interval-based accumulation data is only available from the meter where the meter supports a data logging feature. Where this feature is available, data logs are generally accessed via reading Method B.

10.3. Capturing data from MDPs

In cases where Seqwater utilises a Meter Data Provider to capture Submetering or Revenue metering information, the meter data must be imported into Seqwater's data systems such that it can be used for billing or Clean Energy

Certificate (CEC) generation (as appropriate). The meter data shall also be imported into the EMaAP platform for internal reporting and analytics.

For this purpose, meter data from the MDP shall be imported into Seqwater's systems via an Application Programming Interface (API) or appropriate data stream. Most MDPs have facilities to post meter data in NEM 12 format, a standard data format used for market settlement in the NEM.

The NEM 12 format is defined in the AEMO document "Meter Data File Format Specification NEM12 and NEM13".

These methods may also be used to import data from the revenue meter data into the EMaAP.

10.4. Emissions Logging

Capturing emissions data is an integral part of Seqwater's energy strategy. As per the National Greenhouse and Energy Reporting (NGER) legislation, Seqwater must report indirect emissions from electricity consumption[10].

Although site-level billing data can be utilised for NGER reporting, it is beneficial for Seqwater to have a more granular view to monitor and improve emissions from individual processes or subsystems. Additional metering, as described in this Guideline, can be used for this purpose.

It is expected that the logical separation for metering detailed in Section 5.2 will suffice for improved emissions monitoring as SEUs within Seqwater correspond closely to significant emitters.

There may be cases where the preferred logically separation of loads may differ for targeted emissions optimisation. The justification for metering these cases may vary from that considered in the assessment tool and shall be assessed on a case-by-case basis.

As discussed in Section 6.6.3, virtual metering may be helpful for aggregating metering data for emissions monitoring and reporting.

11. Changes from the previous version

This Guideline will be regularly reviewed and updates, including the consideration of requested alterations.

Section Number	Change
N/A	First Version

12. Further Information

For further information on this Guideline, please contact the Energy Team: energy@seqwater.com.au

[10] "Scope 2 emissions" as per the NGER legislation

13. Definitions

Term	Definitions
Employees	Means persons employed directly by Seqwater in a permanent, temporary, or casual capacity.
Leader	Means any Level 1, 2, 3, 4 and 5 workers with responsibility for managing a functional area of the business, including people management responsibilities within their functional area.
Worker(s)	Includes all permanent, temporary, and casual employees of Seqwater, and: • vocational and work experience placements • volunteers • contractors and consultants employed by another entity but temporarily assigned to do work for or on behalf of Seqwater.
Meter	In the context of this document, the term "Meter" is any meter included in Section 1 Purpose and Scope
Energy Meter	An electricity meter used primarily to measure the energy consumption of an asset or process
Submeter	An electricity meter used primarily to measure the energy consumption of a third-party or embedded generator
Performance Meter	Any measurement device used to measure production information for the purpose of developing Energy Performance Indicators (EnPIs)
Scope 2 emissions	Scope 2 greenhouse gas emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity.
"the rules"	In the context of this document, "the rules" refers to the National Electricity Rules

14. Abbreviations

Abbreviation	Definitions
AC	Alternating Current
API	Application Programming Interface
AEMC	Australian Energy Market Commission

Abbreviation	Definitions
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AS	Australian Standard
Avg	Average
BAU	Business As Usual
CO_2	Carbon Dioxide
CEC	Clean Energy Certificate
CER	Clean Energy Regulator
CT	Current Transformer
CSP	Customer Strategy and Planning
DC	Direct Current
DAF	Dissolved Air Flotation
EI	Energy Intensity
EMaAP	Energy Monitoring and Analytics Platform
EnPIs	Energy Performance Indicators
EMIS	Energy Management Information System
FY	Financial Year
GW	Gigawatt
HVAC	Heating Ventilation and Cooling
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
SI	International System of Units
L-L	Line to Line
L-N	Line to Neutral
LGC	Large-scale generation certificates
L	Litres
LAN	Local Area Network
ML	Megalitres
MV	Megavolts
MW	Megawatts
MDHE	Meter Data Head End
MC	Metering Coordinator

Abbreviation	Definitions
MP	Metering Provider
MPB	Metering Provider category B
MDP	Metering Data Provider
M	Metres
NER	National Electricity Rules
NEM	National Electricity Market
NGER	National Greenhouse and Energy Reporting
NMI	National Measurement Institute
NMP	National Metrology Procedure
NSP	Network Services Provider
NZS	New Zealand Standard
OT	Operational Technology
PV	Photovoltaic
POD	Planning, Operations and Delivery
RFDT	Reference Framework and Decision Tool
REPQ	Registered Professional Engineers of Queensland
RIO	Remote In Out
REA	Renewable Energy Act
SEU	Significant Energy Use
SLD	Single Line Diagram
STC	Small-scale Technology Certificates
SME	Subject Matter Expert
SCADA	Supervisory control and data acquisition
3P	Three Phase
THD	Total Harmonic Distortion
UV	Ultraviolet
UK	United Kingdom
VT	Voltage Transformer
WSAA	Water Services Association of Australia

15. References and Related Materials

The documents listed in Table 15 and Table 16, and the requirements therein, are relevant to this Guideline. In their latest editions, these documents form a part of this Guideline. Note that this is not an exhaustive list of documents relevant to the works.

Description	Location
D21/51703 EMaAP - User Req Prioritisation	Rex
GDE-00345 DTI Performance - IoT Reference Framework & Decision Tool Guideline	Rex & Waternet
PLN-00393 DTI Performance - Seqwater Energy Management System & Plan (EnMSP)	Rex & Waternet
PLN-00452 Seqwater Corporate Energy Strategy	Rex & Waternet
SPE-00358 Corporate DTI - I-SPE-STD-009 Control Systems Architecture Specification	Rex & Waternet
SPE-00361 Corporate DTI - I-SPE-STD-013 - Control Systems Design and Construction Engineering Standard	Rex & Waternet
SPE-00352 Engineering Standard E-SPE-STD-001 Electrical Design and Construction	Rex & Waternet
D21/61965 EE Checklist Appendix	Rex
D21/61966 Energy Efficiency Checklist	Rex
D21/63060 Meter Qualification Tool	Rex
D21/67249 EMIS Achieving Improved Energy Efficiency	Rex
D21/43463 Energy Efficiency Guideline for Pumping Applications	Rex

Table 15: Reference Seqwater Documentation

Standard/Specification	Document Title
AS ISO 1000	The International System of Units (SI) and its Application
ISO 50001	Energy Management Systems
AS/NZS 3598	Energy Audits

Table 16: Reference External Standards, Specifications and Codes

Appendix A

The formula for determining minimum power and current thresholds for meter justification is shown in Figure 17.

$$Pmin = \frac{Mc}{S\ P\ Ec\ Df\ Lf\ 87.6}$$

$$Imin = \frac{2.5\ Pmin}{Pf\ \sqrt{3}}$$

Figure 17: Formula for determining the minimum Power and Current for meter justification

Where:

Mc = Meter Cost ($)

S = Expected Savings (%)

P = Payback (years)

Ec = Energy Cost ($/kWh)

Df = Duty factor

Lf = Load factor

Pf = Power factor

P*min* = Power minimum (kW)

I*min* = Current minimum (A)

Note that these are the minimum *nominal* ratings of the circuit. Care must be taken when reviewing SLDs to ensure that these are not confused with maximum ratings.

Appendix B

Metering installation types utilised within the NEM are outlined in Table 17. This table has been simplified and does not contain all caveats and exceptions as included in the NER Chapter 7.

Meter Type	Annual Volume	Accuracy (%)	Equipment Class	Description
Type 1	>1000 GWh	0.5 active 1 reactive	0.2 CT/VT/meter Wh 0.5 meter varh	Remotely read interval meter
Type 2	100-1000 GWh	1 active 2 reactive	0.5 CT/VT/meter Wh 1.0 meter varh	Remotely read interval meter
Type 3	0.75 – 100 GWh	1.5 active 3 reactive	0.5 CT/VT 1.0 meter Wh 2.0 meter varh	Remotely read interval meter
Type 4	0 - 750 MWh	1.5 active	0.5 CT and 1.0 meter Wh or whole current general purpose meter Wh	Remotely read interval meter
Type 4A	0 – 100MWh*	1.5 active	0.5 CT and 1.0 meter Wh or whole current general purpose meter Wh	Remotely read interval meter with communications disabled
Type 5	0 – 0 MWh*	1.5 active	0.5 CT and 1.0 meter Wh or whole current general purpose meter Wh	Manually read interval meter
Type 6	0 – 750 MWh* (Off market) 0 – 100 MWh* (On Market)	2 active	CT or whole current general purpose meter Wh	Manually read accumulation meter Must be capable of upgrading to Type 4 without replacement*

Table 17: Metering Installation Types (Simplified)

*Queensland specific requirement

Appendix C

Figure 18 demonstrates the process flow for the nomination of a Metering Coordinator and the subsequent provisioning of metering services.

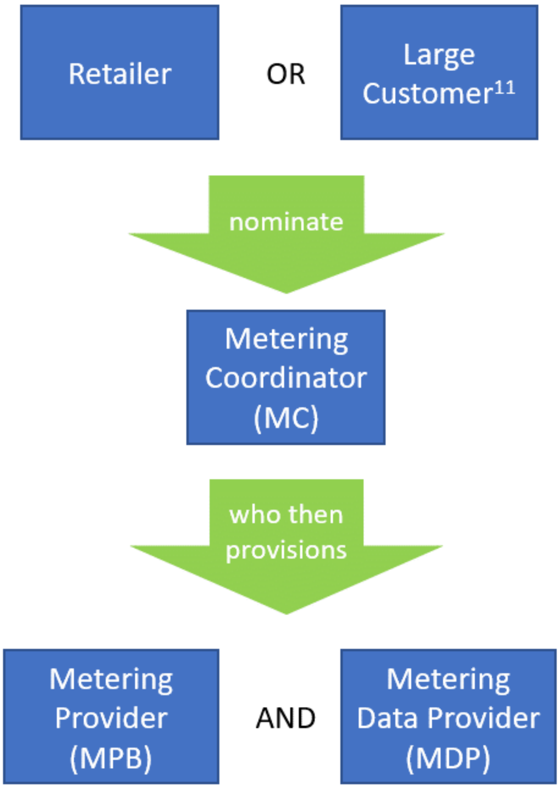


Figure 18: The nomination and provision of metering services

Metering Coordinators (MC) are responsible for provisioning metering services and ensuring that metering installations are provided, installed, and maintained according to the rules.

Metering Providers "Category B" (MPB) are accredited to provide, install and maintain metering installations. Metering Data Providers (MDP) are accredited to collect, process and deliver meter data to market participants.

It is not uncommon for the same company to perform all three roles. A list of accredited Meter Coordinators can be found here.

[11] In Queensland, a large customer is generally any customer that consumes greater than 100MWh per annum.

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