Asset Management Plan – Metering

Power and Water Corporation

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Commercial-in-Confidence (section 10)

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Executive Summary

This metering AMP relates to management of Power and Water's electricity metering assets for both regulated and non-regulated assets.

In line with Power and Water's organisational values which put a great emphasis on customer satisfaction and safety, the metering AMP focuses on implementation of the practices that support safety of the staff and public without undermining its statutory obligations.

The information in this Metering AMP also includes assumptions, estimates, forecast, predictions and projections based on the data at the time. These assumptions has been included in this document in support of Power and Water's Australian Energy Regulator (AER) price determination where required. In addition, the document also provides historical data prior to 2016 for the purpose of basis of preparation for Regulatory Information Notice. The document further provides the source of information and related systems where the information has been obtained.

The Metering AMP covers a combination of monitoring and planned maintenance testing to ensure regulatory compliance for all electricity metering assets for which Power Networks has responsibility for in the NT. It is important to note that, pursuant to clause 7A.4.1(b)(1) and 7A.4.2(b)(1) of Chapter 7A of the National Electricity Rules, the Network Service Provider is taken to be the accredited Metering Provider and Metering Data Provider in the NT.

Subsequently, Power and Water is responsible for testing and inspection of the metering installations for all revenue electricity meters in the NT market. Power and Water provides all Low Voltage (LV) and High Voltage (HV) instrument transformers to customers in the NT market and only purchases pattern approved meters.

Unlike other jurisdictions, Power Networks does not have obligations for its Metering AMP to be approved by AEMO, however the practices within this Metering AMP are in line with practices approved by AEMO to ensure future adaptation of Chapter 7 of the Rules within the National Electricity Market (NEM) and will have minimal impact on this Metering AMP.

Metering Services has developed this metering AMP to ensure the products purchased, installed and maintained meets the statutory requirements as defined in chapter7A of the rules, National Measurement Act and the AEMO guideline document (Sample Testing – AEMO, Alternate Testing Minimum Requirements - Low Voltage Current Transformer Metering Installations).

The Metering AMP provides the strategy relating to:

- new and replacement meter fleet;
- maintenance of metering installations including inspection and testing methodologies; and
- disposal of assets.

1 Purpose

The purpose of this asset management plan (AMP) is to define Power and Water Corporation's (Power and Water's) approach to managing metering assets. It frames the rationale and direction that underpins the management of these assets into the future:

- Short Term (0-2 years): Detailed maintenance and capital works plans for the upcoming financial year based on current asset condition.
- Medium Term (2-5 years) 2019-24 Regulatory Period: Strategies and plans based on trends in performance and health indicators.
- Long Term (5-10 years) 2024-29 Regulatory Period: Qualitative articulation of the expected long-term outcomes.

The metering AMP is part of a suite of documents that encapsulate the management of Power and Water's electricity network assets and its asset management system (AMS). The suite includes higher-level asset management (e.g. policy and strategy), interfacing systems (e.g. risk management), sister AMPs for other asset classes, and detailed business cases for asset investments.

2 Scope and objectives

2.1 Asset class overview

In-scope assets include Power and Water owned metering within the regulated networks for measuring the consumption of electricity in high-voltage (HV) and low-voltage (LV) electrical installations. It also covers generation and wholesale point metering, and metering in non-regulated networks when contracted to do so. Table 2.1 provides an overview of the asset class for regulated networks and Table 2.2 for non-regulated networks.

The scope does not include non-asset management functions such as meter reading, metering communications or non-network IT and communications.

Table 2.1: Overview of in-scope meter assets – regulated networks

Asset	Single phase dynamic (Induction disk)	Single phase static	Three phase dynamic (Induction disk)	Three phase static	North	South	Total
HV connected	0	0	0	129	129	0	129
LV CT connected	801	0	30	2,034	2,284	581	2,865
Whole current	76,475	20,493	1,803	5,046	91,015	18,584	103,817
Prepaid		3,379	0	0	1,727	1,652	3,379
Total	80,655	20,493	1,833	7,209	95,155	20,817	110,190

Table 2.2: Overview of in-scope meter assets – non-regulated networks

Asset	Single phase dynamic (Induction disk)	Single phase static	Three phase dynamic (Induction disk)	Three phase static	North	South	Total
HV connected	0	0	0	0	0	0	0
LV CT connected	218	0	8	228	316	138	454
Whole current	4,618	2,520	327	91	5,742	1,814	7,556
Prepaid		4,913	0	0	1,179	3,734	4,913
Total	7,249	5,020	335	319	7,237	5,685	12,923

The metering asset class is stable, increasing with the volume of new customer connections.

Power and Water's metering assets are distributed throughout its network footprint, which covers the Northern Territory (NT).

2.2 Asset class function

Metering assets are used to measure electrical energy flows at a point in the network for revenue billing purposes. They are installed to meet the requirements of Chapter 7A of the NT National Electricity Rules (NT Rules) at:

- Generators
- Bulk supply points (wholesale meters)
- Consumers.

Schedule 7A.1 of Chapter 7A of the NT Rules prescribes the types of metering installations in accordance to the volume limit per annum per connection point. The NT Rules further specify the value of 'X' and 'Y' for its type 6 metering installations where the value of 'X' is set as zero and 'Y' is 750 MWh. As part of Power of Choice and subsequent changes to Chapter 7 of the National Electricity Rules, the new classification of meters includes type 4A metering installations. This classification of metering installations does not exist in the NT. All smart capable meters without communication modules will be programmed as Type 6. The "Types" are set out in Table 2.3.

Table 2.3: Metering types

Type	Volume limit p.a. (GWh)	Equipment type	Meter reading type	Number in service at 2016
Type 1	>1000	0.2 CT/VT/meter Wh, or 0.5 meter VARh	Remotely read interval meter	0
Type 2	100-1000	0.5 CT/VT/meter Wh, or 1.0 meter VARh	Remotely read interval meter	11

Type	Volume limit p.a. (GWh)	Equipment type	Meter reading type	Number in service at 2016
Type 3	0.75-100	0.5 CT/VT/meter Wh, or 1.0 meter VARh, or 2.0 meter VARh	Remotely read interval meter	255
Type 4	<0.75	0.5 CT/VT/meter Wh, or 1.0 meter VARh Whole Current general purpose meter Wh	Remotely read interval meter	3,924
Type 4A	<0.75	0.5 CT/VT/meter Wh, or 1.0 meter VARh Whole Current general purpose meter Wh	Manually read interval meter	0
Type 6	<0.75	CT, or Whole Current general purpose meter Wh	Manually read accumulation meter	110,631
Prepaid		Whole Current prepay	Manually read accumulation meter	8,292

2.3 Asset objectives

The AMP provides a framework which steers the management of the asset class in a manner that supports the achievement of Power and Water's broader organisational goals. The Asset Management strategies are listed in the Strategic Asset Management Plan (SAMP) and are aligned to the Asset Management Objectives and implemented in through Asset Management Plans (specific to asset class) or Strategic Asset Plans as shown in Figure 2.1 below

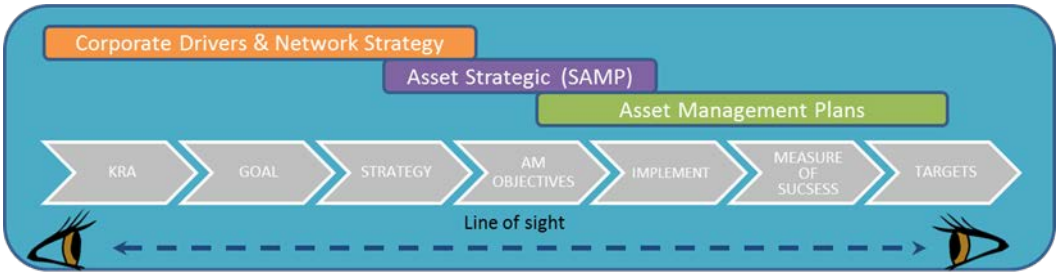

Figure 2.1: Asset Management Line of sight from Corporate and Network strategies through the Asset Management objective to the targets in the asset management plan. Strategic Asset Management

Table 2.4 provides the asset management objectives from the strategies that are relevant to this asset class along with the measures of success and the targets. This provides a 'line of sight' between the discrete asset targets and Power and Water corporate Key Result Areas.

Table 2.4 Asset Management Objectives, Measures of Success and Targets.

Objectives	Measures	Targets
• Network related operation and maintenance tasks are quantified in terms of risk and used to inform investment decisions that affect Health and Safety outcomes for the organisation	• Electric Shock due to neutral connection faults • Electric shocks or near misses due to exposed conductors	• Total asset class specific safety incidents not exceeding TBA
• Engage with our customers, community and stakeholders to demonstrate that we have delivered the best possible solutions • Provide meters to customers in compliance with all relevant statutory requirements.	• Customer Feedback - Track complaints • Smart meter penetration variance from plan	• Number of Complaints not exceeding TBA • Smart meter penetration variance from plan +/- 10%
• Ensure that the systems and processes provide sufficient and appropriate data and information to drive optimal asset and operating solutions. • Use of meter data to enable better decision making in regard to customer needs, augmentation, fault response, safety, revenue protection, power quality and emerging technologies • Proactively and systematically measure the network power quality	• GSL contribution per year Guaranteed Service Levels • Asset class related number of poor power quality incidents.	• TBA
• Ensure that the systems and processes provide sufficient and appropriate financial data • Understand the financial risks associated with asset management	• Variance to AMP forecast CAPEX • Variance to AMP forecast OPEX	• Variance to AMP forecast CAPEX +/-10% • Variance to AMP forecast OPEX +/-10%
• Develop systems and data that facilitate informed risk based decisions • Ensure that works programs optimise the balance between cost, risk and performance • Ensure the effective delivery of the capital investment program	• Network risk index quantified (Y/N) • Health and Criticality Parameters defined (Y/N)	• Achieved
• Identify, review and manage operational and strategic risks • Prioritise projects, programs and plans to achieve efficient and consistent risk mitigation. • Achieve an appropriate balance between cost, performance and risk consistent with regulatory and stakeholder expectations. • Define and communicate the level of risk associated with the investment program	• Critical spares analysis completed for asset class • Operator/Maintainer risk assessment completed for asset class and risk register updated	• Achieved
• Ensure that electricity network assets are maintained in a serviceable condition, fit for purpose and contributing positively to Power Networks business objectives. • Ensure that all meters maintain the required level of accuracy.	• All staff are trained and hold appropriate qualifications for the tasks they undertake. • Peer benchmarking, i.e. a reasonableness test of underlying unit costs (capex, opex)	• Achieved

Table 2.5: Objectives alignment

Corporate objectives	Asset management objectives	Asset class objectives	Measures
Reliable: provide a reliable service to our customers (reliability & quality of supply).	• Maintain power supply quality and reliability. • Achieve compliance with reliability and power quality requirements.	Nil	Nil
Responsible: operate as a responsible corporate citizen (social and environmental responsibility).	• Minimise the likelihood of safety incidents associated with the assets or asset activities (public and workers). • Achieve compliance with public and worker safety requirements.	• Take all reasonable steps to address safety issues associated with metering assets. • Comply with the requirements of Section 7A of the National Electricity Rules.	**Performance indicators:** • Number of safety incidents (near misses, injuries, fatalities). • Compliance breaches with the relevant legislation / regulation / standards.
	• Take all reasonable steps to minimise the impact of the assets or asset activities on the environment and communities. • Achieve compliance with environmental and cultural requirements.	• Provide metering suitable for customers with payment difficulties (prepaid)	Nil
Sustainable: ensure long-term financial sustainability of the business (affordable service and shareholder returns).	• Optimise the balance of total expenditure and risk. • Benchmark in the top quartile of NEM NSPs. • Achieve compliance with NER expenditure objectives.	• Contributing to the achievement of the Corporation's Five Priority Projects through developing capability to respond to 'disruptive technologies' and meet future customer requirements • Evaluate and select preferred investments in view of: - the long term advantages of new metering technologies - expected increases in two way energy flows on distribution networks.	Nil

3 Context

3.1 Roles and responsibilities

Obligations relating to the ownership and management of meters are set out in:

- Network license issued by the Utility Commission dated 31 March 2000, as varied on 3 April 2015
- Chapter 7A of NT Rules
- Power Networks Network Technical Code and Network Planning Criteria
- National measurement Act 1960 (Cth) – National measurement Institute NMI M6
- National Measurement Institute NMI M1

NT's Rules (Chapter 7A) establishes the metering framework that applies in the NT in alignment with NEM principles and methodologies. It provides the framework for metering for local electricity systems by establishing the requirements for metering installations at connection points on transmission networks or distribution networks. This document prescribes the metering installation requirements including testing and inspection methodologies and provision of metering data and overarching principles.

Under Chapter 7A of the NT rules, Power and Water's Metering Services is the sole responsible metering provider and metering data provider in the NT until July 2024. Consequently, Power and Water's Metering Services directly undertakes its obligations for metering on regulated networks as an Alternative Control Service and indirectly for non-regulated networks and IES customers through negotiated Service Level Agreements.

Power and Water's Network license defines the list of regulated and non-regulated networks. Power and Water is responsible for the installation and maintenance of all metering on the regulated networks in NT. Power and Water's Metering Services also undertakes installation and maintenance of all HV and LV Current Transformer (CT) connected metering for non-regulated assets including remote communities, performing this activity under contracts with related parties.

Power and Water Networks is also the Metering Coordinator (MC) for all its connection points within NT until July 2024. Pursuant to Schedule 7A.2 "Inspection and Testing Requirements", the Metering Coordinator (or any other person arranging the testing) must ensure that testing of the metering installation is carried out either in accordance to the requirement of the NT Rules or in accordance with an approved asset management strategy that defines an alternative testing practice (other than time based) determined by the Metering Coordinator. The requirements in relation to approval of an asset management strategy will be considered as part of the phased implementation of the National Electricity Rules in NT. Consequently, the rule requires that the Metering Coordinator develops, maintains and executes its asset management strategy and carries out annual audits on metering providers to ensure that this is being done.

Power and Water is responsible for the entire meter reading activities in the NT.
Metering Services undertake this activity except where Indigenous Essential Services (IES) is the responsible party. For these areas, Essential Services Officers (ESOs) undertake installation of the plugin meters whereas the installations of bottom connected meters are carried out by qualified and licence electrical contractors, including installation of whole current metering installations.

Metering Services may undertake the maintenance of the metering installations if contracted to do so. The summary of the roles and responsibilities is outlined in Table 3.1.

Table 3.1 Roles and responsibilities for metering services

Responsible parties for installation and maintenance of Metering Installations						
Area	Regulated	Non-regulated	Metering Services	IES	Southern Region	Comment
Darwin (City, Suburbs and surrounding rural areas)	√		√			MS responsible for All types of metering
Katherine (township and surrounding rural arears)	√		√			MS responsible for All types of metering
Darwin – Katherine Transmission line (132kV)	√		√			MS responsible for All types of metering
Tennant Creek (township and surrounding areas)	√		√			MS responsible for All types of metering
Alice Springs (township and surrounding rural arears)			√		√	MS also provides services in Alice Springs
Daly River		√	√**	√		**MS performs about 20% of BAU work with majority of simple installations are carried out by ESOs. MS is solely responsible for HV and CT connected metering only
Jabiru		√	√**			**MS performs about 10% of BAU work with majority of simple installations are carried out by ESOs. MS is solely responsible for HV and CT connected metering only
Borroloola		√	√*	√		*MS is responsible for HV and CT connected metering only
Timber Creek		√	√**	√		**MS performs about 10% of BAU work with majority of simple installations are carried out by ESOs. MS is solely responsible for HV and CT connected metering only
Daly Waters		√	√**	√		**MS performs about 10% of BAU work with majority of simple installations are carried out by ESOs. MS is solely responsible for HV and CT connected metering only
Elliott		√	√**	√	√	**MS performs about 10% of BAU work with majority of simple installations are carried out by ESOs. MS is solely responsible for HV and CT connected metering only
Newcastle Waters		√	√*	√		*MS is responsible for HV and CT connected metering only
Yulara		√	√*		√	*MS is responsible for HV and CT connected metering only
Ti Tree		√	√*	√		*MS is responsible for HV and CT connected metering only
Kings Canyon		√	√*		√	*MS is responsible for HV and CT

						connected metering only
Nhulunbuy- Surrounding rural areas Only		√	√*	√		*MS is responsible for HV and CT connected metering only
Groote Eylandt- Angurugu and Umbakumba Only		√	√*	√		*MS is responsible for HV and CT connected metering only
Indigenous Communities under the indigenous Essential Services Program		√	√*	√		*MS is responsible for HV and CT connected metering only

3.2 Relationship with the Strategic Asset Management Plan (SAMP)

The SAMP sets out how Power Networks will achieve the corporate objectives of reliable, responsible, and sustainable operation of the power network. The asset class AMP describes how individual asset classes will deliver the SAMP. It explains the challenges associated with the asset class and lays out the investment programmes to manage the asset class and achieve the corporate objectives.

3.3 Relationship with the Network Management Plan

The Network Management Plan (Plan) explains Power and Water's intentions for the next five years in relation to network reliability, capacity, security and supply quality and the accompanying development of the network.

The NMP provides insight into the important challenges Power Networks faces and how Power Networks will respond. It also provides information on network management practices and proposed development of the network over the next five-year period.

The NMP informs the AMP on growth and augmentation investment requirements.

3.4 Investment planning process

The primary drivers of investments in the power network for the period of this plan are set out in the SAMP and involve safety, growth and security of supply, reliability of supply, and the environment.

Key factors include condition and performance of assets and the associated risk of critical asset failures. To meet this key business objective and to respond to the drivers for investment, the AMP aims to achieve the following:

- safety of employees, customers and the public;
- optimised asset performance;
- optimised asset lifecycle costs;
- timely replacement of assets; and
- environmental compliance.

3.4.1 Identification of needs

With respect to asset replacement, the identification of needs is guided by the risk profile for the asset. Table 3.2 provides the guiding principle for the adoption of the most appropriate asset management strategy.

Table 3.2 Asset management approach

Asset Management Strategy	Asset risk profile suitability
Run-to-failure Reactive (functional failure)	- Asset has low criticality, low consequence - Asset condition information is difficult to gather
Condition based (Conditional failure)	- Asset is critical and function failure is likely to result in consequences with a likelihood adjusted NPV that is greater than the replacement cost - Asset condition is measurable
Planned Pro-active – other driver	- Other risks result in action (e.g. network need is changing, emerging safety or environmental risks, change in technology, legislative and compliance changes) - Asset condition may be measurable and can be used to prioritise replacements

For augmentation investment, the guiding principle is to be able to connect customers in a timely manner.

3.4.2 Selection of options and solutions

The metering installation lifecycle management strategy includes but is not limited to:

- Time Based Inspection
- Accuracy testing
- Meter asset health check through data validation.

Management of the strategy is based on a simple plan-do-check approach. The objective is to ensure the proposed strategy is effective and compliant with business and regulatory requirements. Table 3.3 sets out the asset risk profile suitability.

Table 3.3 Asset risk profile suitability

Asset Management Strategy	Asset risk profile suitability
Repair / life extension	- Power and Water is not a verifying authority and hence does not repair meters. Meters are replaced if found non-conforming. - Strategy is aligned to business and regulatory requirements
Piece-meal replacement	- As part of technology changes, the induction disk meters are being faced out by piece meal replacement program
Compliance	- Audit - Service Level Agreement - Identify and report on maintenance issues (systematic failure, end of Life etc.
Skills and Training	- Maintenance of the technical and management skills - Awareness of regulatory changes through information sessions such as Tool Box Meetings etc.
Opportunity Planning	- BNI preparation - Regulatory Changes - New Business requirements - New Customer requirements - Technology changes
Operations	- Monitor alarm

Asset Management Strategy	Asset risk profile suitability
	- Load monitoring - Supply Quality

4 Asset base

4.1 Overview

Power and Water owns and maintains a portfolio of more than 140,000 metering assets of which 88% are meters and 12% are metering ancillaries, distributed across the four regions of Alice Springs, Darwin, Katherine, and Tennant Creek with the largest population in the Darwin Region.

The portfolio consists of a variety of meter types, with Single Phase Electromechanical Meters comprising the majority (68%), followed by Single Phase Electronic (1 and 2 Elements) meters (19%). Different meter types have been used depending on the preferred technology at the time of installation, or functional requirements such as prepayment.

Metering ancillaries consist of voltage transformers (VTs), current transformers (CTs), and communication equipment – modems and antennas.

4.2 Asset types

Whole current meters predominate. Only 3% are connected via CTs/VTs.

Whole current meters are either direct connected (bottom connected) or plug-in. Where appropriate, communications equipment is added to the meter to allow remote meter reading (3% of meters).

In accordance with Power and Water's strategy[1]:

- All new meters are either plug-in or bottom connect types.
- All new and replacement domestic installations are of type 4 smart meters with disconnect relays and capability of registering import and export energy. Where there is no telecommunication network available, Power and Water will continue to install smart ready meter that are upgradeable with the addition of an optional telecommunication module. These meters will be programmed as type 6 metering installations.

An overview of the different metering types and ancillaries is provided in Table 4.1.

Table 4.1: Metering types comprising the metering asset population

Asset type	Volume regulated	Volume un-regulated	Total volume
Single Phase Electromechanical Meters	76,475	7,031	83,506
Single Phase Electronic (1 and 2 Elements) – No Communications Module	18,692	5,020	23,712
Single Phase Electronic (1 and 2 Elements) – With Communications Module	1,801	0	1,801

[1] PWC's strategy is set out in Business Needs Identification – Metering, new and replacement policy

Asset type	Volume regulated	Volume un-regulated	Total volume
Prepaid Meters (PAYG) – [redacted] card token meters	3,379	2,644	6,023
Prepaid Meters (PAYG) – Electronic Smart meters	0	2,269	2,269
Three Phase Electromechanical Meters	1,803	327	2,130
Three Phase Electronic Meters Whole Current – No Communications Module	2,780	79	2,859
Three Phase Electronic Meters Whole current – With Communications Module	2,266	12	2,278
Low Voltage Current Transformer (LV CT) Electronic Meters	2,034	228	2,262
Low Voltage Current Transformer (LV CT) Electromechanical Meters	831	226	1,057
HV Customer Electronic Meters	75	0	75
HV Wholesale Electronic Meters (Revenue)	51	0	51
HV Wholesale Electronic Meters (Check)	3	0	3
Total Meters	110,190	12,923	123,113
LV CT (Toroidal)	6,843	1,362	8,205
LV CT (Split Core)	150	0	150
Voltage Transformer (VT)	129	0	129
Modems	4,190	12	4,202
Antennas	4,190	12	4,202
Total Meter Ancillaries (excluding meters)	15,502	1,386	16,888

Communications Equipment

Power and Water have approximately 4,190 modems installed across the Territory. This number continues to grow rapidly. The modem types are detailed in Table 4.2. All 2G modems have been replaced with 3G modem as a result of Telstra's decision to decommission its 2G network. In general, one modem is used for each metering installation for single phase and three phase with an exemption of three single phase meters in lieu of three phase installations where three individual modems are used.

Table 4.2 Installed modem types

Make	Carrier
[redacted]	3G
[redacted]	4G

4.3 Asset population analysis

A detailed breakdown of the portfolio of metering assets is provided in Table 4.3 to Table 4.7.

Table 4.3: Power and Water WC meter family population within the Regulated Assets

Whole Current Meter	Installation Year	Number of Meters	Config	North	South	Plugin Y/N
[redacted]	1980	215	3P3E	163	52	N
	1980	21	1P1E	0	21	N
	1980	185	1P1E	17	168	N
	1980	634	1P1E	166	468	N
	1981	482	3P3E	441	41	N
	1981	1989	1P1E	1,592	397	N
	1981	5840	1P1E	4,746	1,094	N
	1982	3	1P1E	1	2	N
	1984	8	3P3E	6	2	N
	1985	1084	3P3E	891	193	N
	1986	731	1P1E	668	63	Y
	1986	17590	1P1E	13,113	4,477	Y
	1989	411	1P1E	107	304	N
	1993	5140	1P1E	3,879	1,261	N
	1995	19	2P2E	18	1	N
	1999	7	3P3E	4	3	N
	1999	7	3P3E	3	4	N
	2000	12	1P1E	5	7	N
	2000	329	1P1E	100	229	Y
	2000	6	1P1E	6	0	N
	2000	118	1P1E	113	5	Y
	2001	24	3P3E	23	1	N
	2001	1	3P3E	0	1	N
	2001	42388	1P1E	38,168	4,220	Y
	2005	25	1P1E	21	4	N
	2005	38	1P1E	37	1	Y
	2005	25	3P3E	25	0	N
	2005	3,270	1P1E	2,679	591	N
	2006	36	1P1E	36	0	N
	2006	77	1P1E	77	0	Y
	2006	84	1P1E	84	0	N
	2006	65	1P1E	34	31	N
	2006	541	1P1E	271	270	Y
	2008	19	3P3E	19	0	N
	2008	2	3P3E	2	0	N
	2009	248	1P1E	79	169	N
	2009	2183	1P1E	1,238	945	Y
	2010	975	1P1E	975	0	N
	2010	115	1P1E	110	5	N
	2010	1405	1P1E	1,391	14	Y
	2010	1884	3P3E	1,594	290	N
	2010	6048	1P1E	4,720	1,320	N
	2011	1787	3P3E	1,400	387	N
	2011	4055	1P1E	3,722	333	N
	2011	1285	3P3E	1,128	157	N
	2011	2667	1P2E	1,748	919	N
	2013	4726	1P1E	4,592	134	N
	2013	10	1P1E	10	0	N
	2013	566	1P1E	566	0	Y
	2016	158	1P1E	158	0	N
	2016	69	1P1E	69	0	N
Total Whole Current Meters		**109,607**		**91,015**	**18,584**	

Table 4.4: Power and Water Meter WC family population within the "Non – Regulated" Assets

Whole Current Meter	Installation Year	Number of Meters	Config	North	South	Plugin Y / N
[redacted]	1980	0	3P3E	0	0	N
	1980	0	1P1E	0	0	N
	1980	4	1P1E	0	4	N
	1980	0	1P1E	0	0	N
	1981	2	3P3E	2	0	N
	1981	2	1P1E	0	2	N
	1981	17	1P1E	5	12	N
	1982	0	1P1E	0	0	N
	1984	0	3P3E	0	0	N
	1985	324	3P3E	321	3	N
	1986	20	1P1E	12	8	Y
	1986	1548	1P1E	876	672	Y
	1989	378	1P1E	374	4	N
	1993	510	1P1E	284	226	N
	1995	1	2P2E	1	0	N
	1999	0	3P3E	0	0	N
	1999	0	3P3E	0	0	N
	2000	2	1P1E	1	1	N
	2000	114	1P1E	5	109	Y
	2000	0	1P1E	0	0	N
	2000	1	1P1E	1	0	Y
	2001	0	3P3E	0	0	N
	2001	0	3P3E	0	0	N
	2001	4009	1P1E	2837	1172	Y
	2005	0	1P1E	0	0	N
	2005	1	1P1E	1	0	Y
	2005	0	3P3E	0	0	N
	2005	332	1P1E	106	226	N
	2006	0	1P1E	0	0	N
	2006	0	1P1E	0	0	Y
	2006	0	1P1E	0	0	N
[redacted]	2006	3	1P1E	1	2	N
	2006	41	1P1E	16	25	Y
	2008	1	3P3E	1	0	N
	2008	0	3P3E	0	0	N
	2009	4	1P1E	0	4	N
	2009	2480	1P1E	1167	1313	Y
	2010	0	1P1E	0	0	N
	2010	0	1P1E	0	0	N
	2010	5	1P1E	4	1	Y
	2010	70	3P3E	32	38	N
	2010	86	1P1E	64	22	N
	2011	0	3P3E	0	0	N
	2011	211	1P1E	176	35	N
	2011	20	3P3E	14	6	N
	2011	1	1P2E	0	1	N
	2013	2269	1P1E	2261	8	N
	2013	0	1P1E	0	0	N
	2013	13	1P1E	13	0	Y
	2016	0	1P1E	0	0	N
	2016	0	1P1E	0	0	N
Total Whole Current Meters		**12,469**		**8,575**	**3,894**	

Table 4.5: Power and Water LVCT and LVCT connected meter population within the Regulated Assets

CT meter model	Installation year	No. CT connected meters	No. of current transformers	Configuration	North	South
[redacted]	1981	22	66	3P3E	21	1
[redacted]	2000	8	24	3P3E	5	3
[redacted]	1985	220	220	1P1E	151	693
[redacted]	1985	7	7	1P1E	7	0
[redacted]	1988	574	574	1P1E	430	144
[redacted]	1999	3	9	3P3E	0	3
[redacted]	2000	7	21	3P3E	3	4
[redacted]	2002	0	0	3P3E	0	0
[redacted]	2004	17	51	3P3E	16	1
[redacted]	2009 - current	2007	6021	3P3E	1651	356
Total		2865	6993		2,284	581

Table 4.6: Power and Water LVCT and LVCT connected meter population within the Non-regulated Assets

CT meter model	Installation year	No. CT connected meters	No of current transformers	Configuration	North	South
[redacted]	1981	2	3	3P3E	2	0
[redacted]	2000	6	18	3P3E	5	1
[redacted]	1985	33	33	1P1E	26	7
[redacted]	1985	3	3	1P1E	3	0
[redacted]	1988	182	182	1P1E	153	29
[redacted]	1999	0	0	3P3E	0	0
[redacted]	2000	0	0	3P3E	0	0
[redacted]	2002	0	0	3P3E	0	0
[redacted]	2004	1	3	3P3E	1	0
[redacted]	2009 - current	227	681	3P3E	126	101
Total		454	923		316	138

Table 4.7: Power and Water HVCT and HVCT connected meter population within the Regulated Assets

CT meter model	Installation year	HV installations	No of VTs	No of CTs	Configuration	North	South
[redacted]	2001	0	0	0	3P3E	0	0
[redacted]	2005	0	0	0	3P3E	0	0
[redacted]	2009	2	2	6	3P3E	2	0
[redacted]	2012-2016	73	73	219	3P3E	62	11
[redacted]	2015-22017	19	19	57	3P3E	19	0
[redacted]	2015-22016	2	2	6	3P3E	2	0
[redacted]	2016-2017	33	33	99	3P3E	25	8
Total		129	129	387		110	19

Note: There are no HV metering installations in non-regulated networks

4.4 Asset Profile

4.4.1 Age profile

The age profile of meters is shown in the following figures.

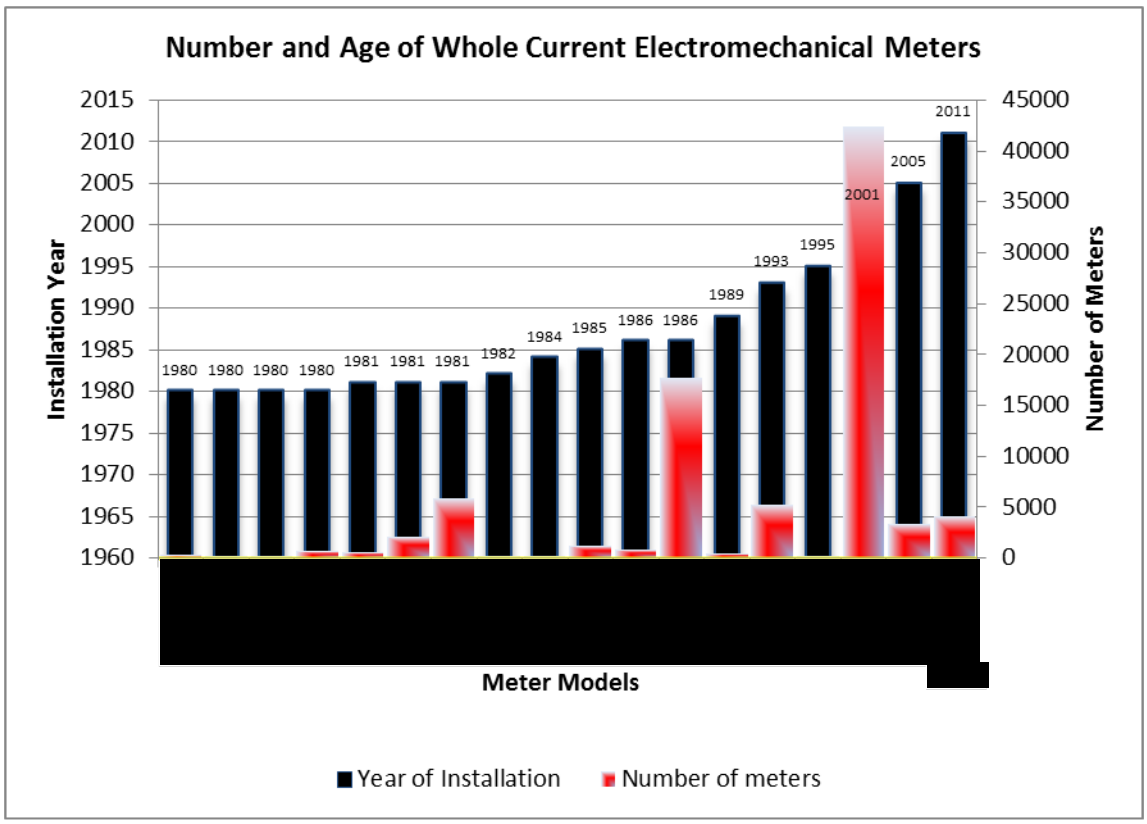

Figure 4.1: Whole current electromechanical meters – age profile

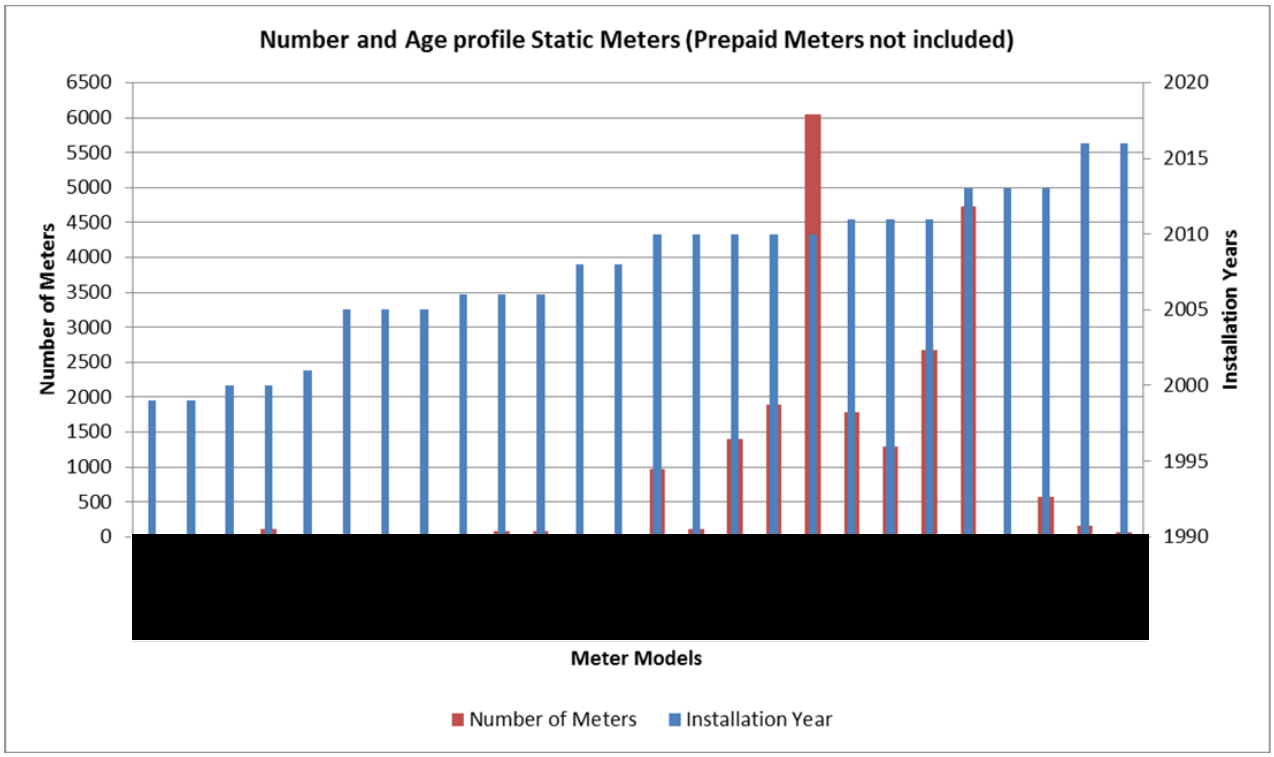

Figure 4.2: Static meters (excluding prepaid) – age profile

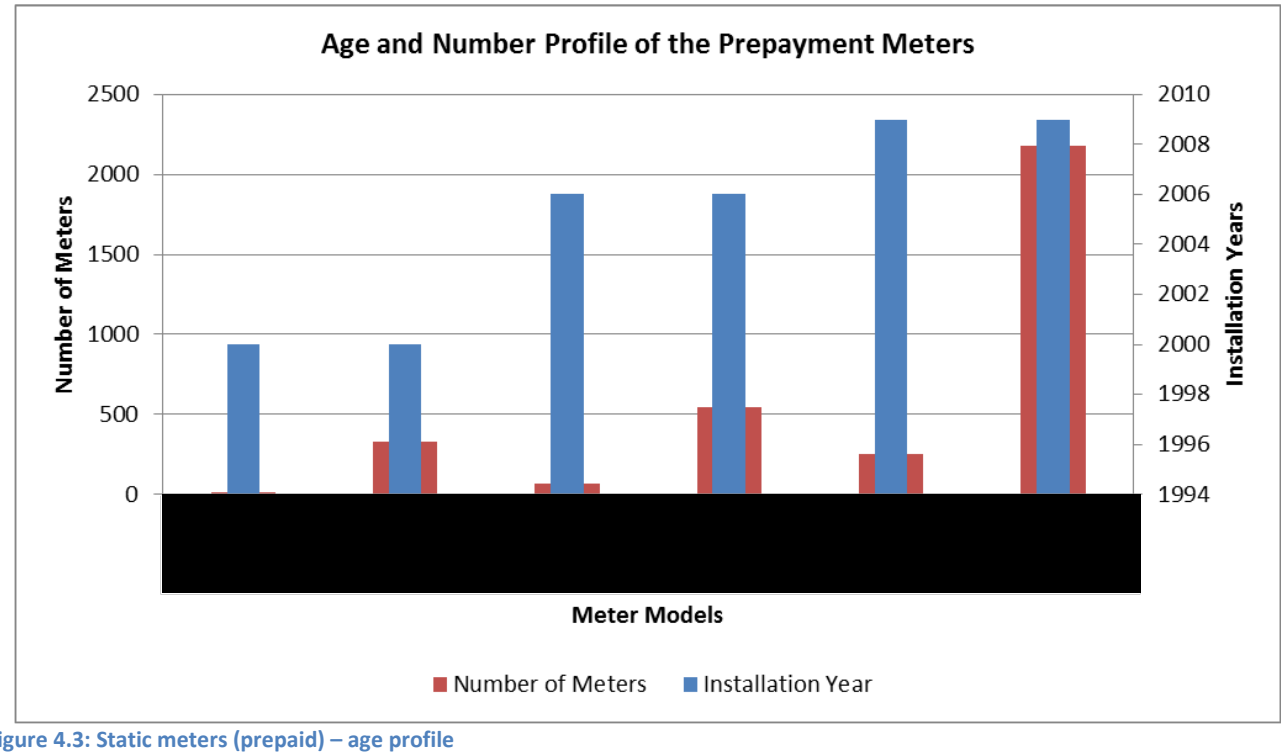

Figure 4.3: Static meters (prepaid) – age profile

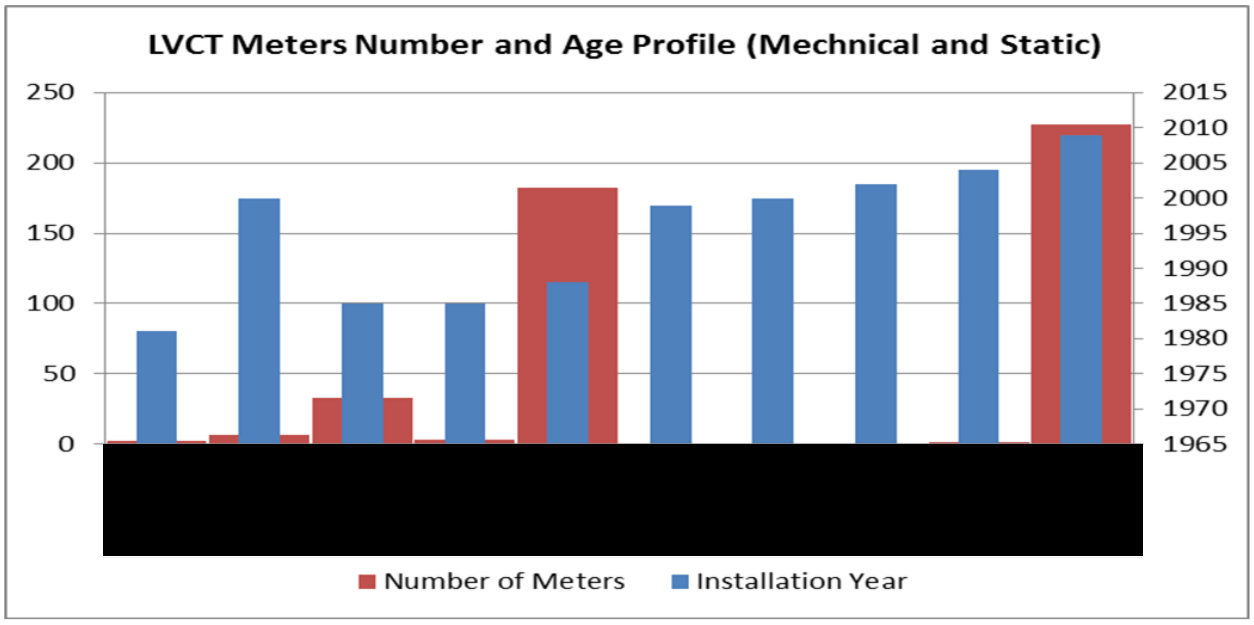

Figure 4.4: LVCT meters – age profile

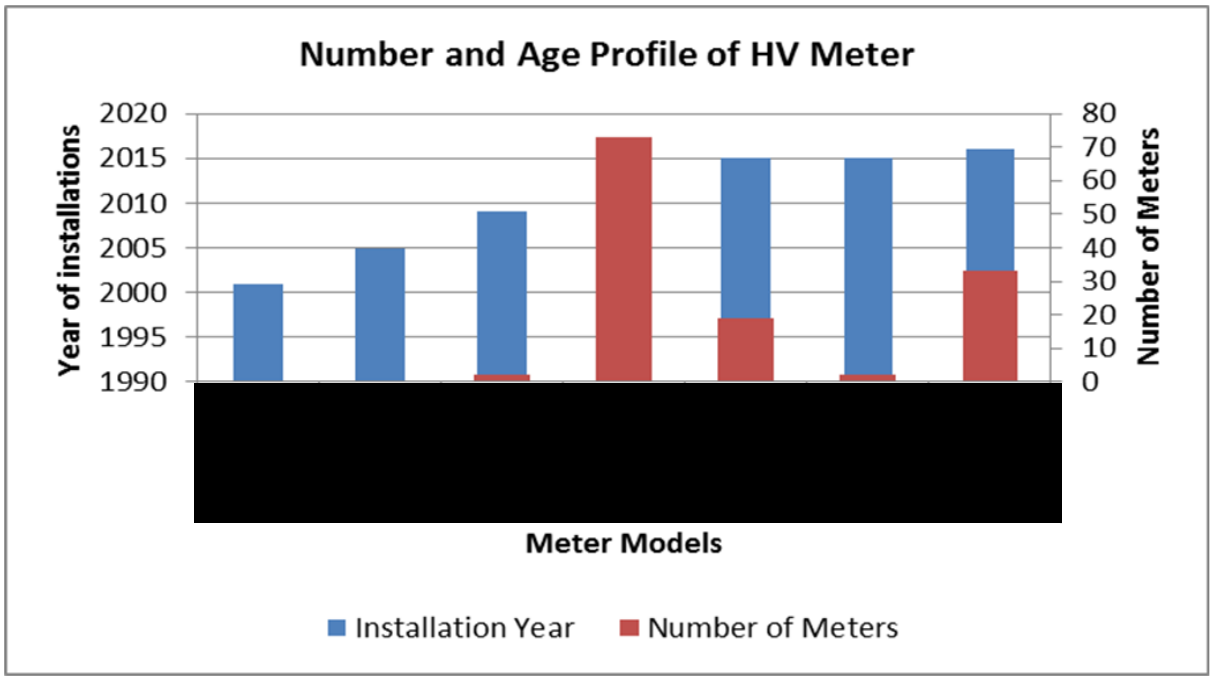

Figure 4.5: HV meters – age profile

Table 4.8: Age and remaining life

	Darwin	Katherine	Tennat Creek	Alice Springs	Life		
Age	Number of Meters	Number of Meters	Number of Meters	Number of Meters	Static 15 years	Mechanical 35 years	PrePaid
1	227	0	0	0	227	0	0
3	7,142	299	19	124	7,584	0	0
6	50	15	2	9	76	0	0
8	6,564	224	95	1,356	3,973	4,266	0
9	9,962	728	184	2,144	13,018	0	0
10	19	1	0	0	20	0	0
11	182	15	0	0	197	0	14
13	53	10	6	9	64	0	4,723
14	946	1,492	581	1,710	6	0	582
16	119	210	150	156	1	52	0
17	1,333	272	35	439	2,079	0	0
19	26	1	1	3	31	0	0
20	143	79	100	247	126	0	443
26	2,679	106	117	700	0	3,602	0
29	3,732	431	151	1,336	0	5,650	0
35	12,253	1,746	397	4,752	0	19,148	0
36	36,593	4,995	533	5,032	0	47,153	0
37	8,558	717	476	2,402	0	12,153	0
				Total of meters	**27,402**	**92,024**	**5,762**
				Total Meter Change	****2,243**	****78,454**	***5,762**

* All Prepaid meters are to be replaced as the existing token meters are no longer supported by vendors.
**For Static and Mechanical meters that have reached their end of life, the sample test of their accuracy will determine if the meters are to be replaced or remain in service.

Even though the electronic meters have a nominal life of 15 years and mechanical meters 35 years, the routine test in accordance to AS1284.13 determines if the family of the meters will be replaced. If the accuracy of meter family has not been drifted outside its statutory limits, the family of meters will remain in service. However, if the family of meters has drifted but still remains within the threshold, the meters may remain in service but the period of the test will be reduced. These meters will be replaced once the meter families are found to be non-compliant.

5 Health and criticality profiles

The health and criticality indices developed for metering assets establishes the context of the risk associated with these assets and defines the parameters that influences how the risk is managed. The asset health is a key driver in the probability of asset failure, and the asset criticality is a key determinant in quantifying the risk associated with the failure.

Total failure of a metering installation can result in loss of supply to an electrical installation, although this is rare and is readily discovered. Substitute consumption data can be inserted, so the impact is generally small.

A more likely failure is an inaccurate measurement of consumption. The inaccurate measurement may not be found until routine testing occurs. Criticality is for metering installations for large customers (>40MWh pa).

Power and Water has not yet applied a criticality rating to each of its meters. This is considered a low priority and does not impact on the ability to manage the asset fleet.

Power and Water has not yet established a health rating for each of its meters. As management is by routine testing of meter families, this is considered a low priority and does not impact on the ability to manage the asset fleet.

6 Key challenges

6.1 Environmental challenges

Meters are installed indoors and do not contain hazardous materials, hence they pose no environmental issues. Previously, some meters were installed on boards containing asbestos and many of these remain in the fleet. All asbestos board removal is carried out by external qualified contractor.

6.2 Operational challenges

Power and Water has two operational challenges:

- Replacement of unsupported prepaid meters
- Post 2018/2019, all meters >40MWh replaced with type 4.

The manufacturer of existing prepaid meters [redacted] no longer supports the token card meters. They are to be replaced by 1 July 2019. There are approximately [redacted] prepaid meters within regulated assets and this plan only makes provision for replacement of these meters. The IES roll out of prepaid meters is not covered under this plan. Metering Services has chosen the [redacted] for its prepaid meter solution moving forward (refer Business case, trim number D2017/283453). The meter is a type 4 meter with disconnect relay built within. The vending and any changes to future programming of meter are done remotely. The meter can be used as credit or prepaid as required.

With respect to metering for >40MWh customers, all new metering will be Type 4 (remotely read interval meters) and existing metering will be converted to Type 4 by the end of FY19 to support Power and Water's innovative tariff structure.

6.3 Asset challenges

Power and Water has two asset challenges for metering assets:

- Assets reaching end of life
- Limited access to metering installations.

Neither of these challenges requires additional funding and they are being managed within the current maintenance expenditure allocation.

1) **Assets reaching end of life**

   All BAZ and AZ meters will be replaced as they have reached their end of life. These meters are the oldest fleet of meters within Power and Water with an average age of 40 years. The life expectancy of induction disk meters is 35 years and these meters have exceeded this expectation. Some AZ and BAZ meters are enclosed in a metal case, which

may pose a safety risk as the body of the meter can potentially rise to 240 V in event of a fault with the meter. These are replaced as priority should they be found.

2) **Limited access**

The biggest challenge is access to metering equipment for testing or replacing, mostly in relation to LV CTs and HV customers. These types of customers do not voluntarily provide access and lengthy negotiation is often required for replacing or testing of existing metering assets. Power and Water works proactively with customers to identify a suitable shut down period, which is based on mutual agreement between both parties.

6.4 Asset management challenges

The key asset management risks and challenges are set out in Table 6.1, together with the current control strategy.

Table 6.1: Asset management challenges

Hazard / Risk	Consequence Category	Hazard Effect	Untreated Likelihood	Untreated Consequence	Untreated Risk Rating	Current Control (Recommended Strategy)	Treated Likelihood	Treated Consequences	Treated Risk Ratings
Vendor Existing in the Australian Market	No technical supports, security issues	Rules, jurisdictional rules non-compliance	Rare	Major	High	• Engage meter vendors who have track records in Australia and overseas. Particularly with similar climate to the NT. • Verification test in the meter laboratory • Maintain at least 700 meters in stock • Continuously look for other similar product	Exceptional	Moderate	Low
Has product been used in Australia or similar environment overseas	Environmental issues, heat, short life span	Short life cycle, meter failure	Possible	Major	High	• Purchase product that has proven record in similar environment • Past industry experience with support and product	Exceptional	Moderate	Low
Catastrophic individual meter failure due to vandalism / Theft / HV injection	Potential injury to public, staff / contractors. Damage to customer property	Injury to the public. Damage to the property	Almost certain	Severe	Very High	• Meter Design to fail safe • Routine inspection for damage prior energisation	Exceptional	Minor	Low
Not monitoring meter alarms	Meter failure, revenue protection, missed opportunity for customer service	Breach of NMI, Financial impact	Almost Certain	Severe	High	• Monitor reports daily • Automate system to ensure alarms are being attended to	Rare	Minor	Low
Security of the meter and the data	Liability to Power and Water, damage stakeholder relationship, GSL	Financial impact, Reputation	Almost certain	Major	High	• Ensure metrology seals are in place • Seal the meter • Password protection	Exceptional	Minor	Low
Deficiencies asset control/ management tools	Loss of meters, avoid warranty	Financial impact, Reputation	Almost Certain	Severe	Very high	• Improve MAXIMO for meter control process	Rare	Minor	Low
Systematic meter failures	Financial impact, Reputation Management	Rules non-compliance	Unlikely	Major	Very high	• 15 year meter warranty • Family testing	Unlikely	Moderate	Medium

7 Performance indicators

The performance of metering assets against the specific objectives and measures identified in section 2.3 are provided here. The performance shown here represents the historical performance of the asset class to date. It is expected that benefits from investments proposed in the next regulatory period will manifest as benefits in these key objectives. The projected investment outcomes in relation to past performance trends are provided in section 11.

7.1 Reliability indicators

Metering assets do not materially impact on reliability.

7.2 Responsibility indicators

Responsibility indicators are set out in Table 7.1.

Table 7.1: Responsivity indicators

Indicator	Description
Number of safety incidents	near misses, injuries, fatalities etc. (Power and Water currently monitors this indicator using promapp)
Audit of metering installation testing	Random audit of accuracy requirements of each individual component plus the overall error of the installation. (There is currently no audit of metering installations; however, Power and Water commenced the audit of its CT connected metering installations in 2014)
Compliance with Chapter 7A of the NER	Monthly reporting by exception. (To commence from FY2019*)

Note: * Chapter 7A to commence from July 2019

Although in the NEM, AEMO conducts a random audit of metering installations to ensure the testing is in accordance to the approved Metering Asset Management Plan, such requirement does not apply to Power and Water. However, as a matter of good practice, provision is made for inclusion of an independent auditor to conduct similar audits.

7.3 Sustainability indicators

No sustainability indicators apply to metering assets.

8 Growth requirements

Metering assets grow at a rate consistent with new housing connections. The assumed growth rate as shown in Table 8.1 is in-line with AEMO's connection forecast dated October 2017.

Table 8.1 New metering growth rates

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Growth rate	0.45%	0.55%	0.77%	0.91%	0.92%	0.45%	0.45%

The starting point for the forecast is the estimated number of meters installed at end FY17 (110,265). The forecast also assumes that:

- As per Power and Water's corporate objective, the number of type 4 metering installations (smart meters - Interval meters with disconnect relay) will increase for all new and replacement domestic metering installations.
- The number of type 6 metering installations (Whole Current) will decline.
- For sites above 40 MWh, all new meters to be type 4 (interval meter with remote acquisition).
- The ratio of meters to customer installations will remain the same as currently exists. [2]
- All future meters are considered to be capable for credit and prepaid metering solution (refer to discussion on new and replacement metering in section 9.1).

Additionally, the forecast assumes that HV connections will add four meters per year. The volume of new meter installations forecast is outlined in Table 8.2.

Table 8.2 New meter installations

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
New meters	495	612	864	1,028	1,050	514	520

[2] A customer may have more than one meter per installation due to: multiple supply points that are separately metered; check metering; new customer in an existing installation with asbestos meter board – install three single phase meters per the asbestos policy (see Appendix B); large users exceeding the capability of a single whole current meter.

9 Renewal and maintenance requirements

The following sections provide an evaluation of renewal and maintenance requirements in relation to metering assets.

9.1 New and replacement policy

Power and Water has established a new and replacement policy to support its innovative tariff reforms that requires:

- All replacement domestic installations are of type 4 smart meters with disconnect relays and capability of registering import and export energy.
- All Whole Current type meters are to be of the plug-in type to facilitate future replacement/upgrading.

The new and replacement policy was tested in 2017 by undertaking a cost/benefit analysis, which is summarised in Table 9.1. Of the 5 options considered, option 3 (Advanced meters enabled immediately) meets the corporate objective for Tariff reform in the shortest timeframe. Other options to not install communications or to target the roll out did not offer a material cost saving and hence are rejected.

Table 9.1 Metering - New and replacement policy CBA

No.	Option	NPV ($m, REAL 2018)
1	Base Case - Advanced capable meters	(126.18)
2	Targeted roll out	(141.08)
3	**Advanced meters, enabled immediately**	**(140.83)**
4	Advanced capable meters, enabled strategically	(140.69)
5	Transition via advanced meters	(141.16)

This plan is consistent with the new and replacement policy.

9.2 Inspection program

9.2.1 Overview

All meters must comply with Chapter 7A of the NT Rules. This is the accuracy requirements of each individual component plus the overall error of the installations. A strategy for the testing and inspection of metering assets is set out in Appendix G. In summary:

- Power and Water determines the accuracy of its metering installations by annual testing.
- Metering assets are managed in “families” that represent common manufacturer and installation dates. The current families are listed in Appendix F.
- Inspection and testing is carried out on metering families in accordance with NT Rules.
- The maximum period between inspections is shown in Table 9.2 and the testing strategy for each metering installation type is summarised in Table 9.3.

Table 9.2 Maximum period between inspections

Meter Type	Power and Water Proposed	Resource (In-house /External)
Type 1	2.5 Years	**In-house**
Type 2	2.5 Years	**In-house**
Type 3 (HV)	3 years	**In-house**
Type 3 (LV)	When Meter Tested	**In-house**
Type 4 (HV)	3 years	**In-house**
Type 4 (LV)	When Meter Tested	**In-house**
Type 6 (HV)	3 years	**In-house**
Type 6 (LV)	**When Meter Tested**	**In-house**

Table 9.3 Metering test and inspection approach

Metering Installation Type	Strategy	Reference Document	Resource
LV Whole Current Meter Testing (Type 6)	*Sample Testing*	*AS/NZ 1284.13*	*Power and Water Staff*
LV Whole Current Metering Installation Inspection	*Full compliance according to NT Chapter 7A*	*In accordance with Table S7A.2.1.3*	*Power and Water Staff*
LV CT Connected Meter Testing (Types 3 & 4)	*Full compliance testing according to NT Chapter 7A*	*In accordance with Table S7A.2.1.2*	*Power and Water Staff*
LV CT Metering Inspections	*An enhanced inspection and data gathering process will be carried out when the CTs are tested.*	*AEMO's guideline: (Alternative Testing Minimum Requirements: Low Voltage Current Transformer Metering Installations)*	*Power and Water Staff*
LV CT Testing	*Sample Testing*	*AEMO's guideline:(Alternative Testing Minimum Requirements: Low Voltage Current Transformer Metering Installations)*	*Power and Water Staff*
HV Meter Testing (Types 1 & 2 & 3)	*Full compliance testing according to NT Chapter 7A*	*In accordance with Table S7A.2.1.2*	*Power and Water Staff*
HV Metering Installation Inspection (Types 1 & 2 & 3)	*Full compliance testing according to NT Chapter 7A*	*In accordance with Table S7A.2.1.3*	*Power and Water Staff*
HV CT & VT Testing (Types 1 & 2 & 3)	*Full compliance testing according to NT Chapter 7A*	*In accordance with Table S7A.2.1.2*	*Power and Water Staff / external resources if primary injection test required*

In the NEM, AEMO conducts random audits of metering installations to assess the effectiveness of the inspection and testing program. Similarly, Power and Water will organise an independent auditor to undertake this activity and the audit findings will be the basis of Power and Water metering assets' performance.

9.2.2 Issues and options

No issues are being experienced.

9.2.3 Asset management plan

The number of meters forecast to be inspected and/or tested is shown in Table 9.4 and Table 9.5, while the number of CTs forecast to be tested is shown in Table 9.6 and Table 9.7. With respect to testing of CTs, note that:

- Despite AEMO's recommendation for one CT to be tested at each site, Power and Water will test all CTs to minimise any inconvenience to customer as the interruption to supply has been made at the time of the test.
- There are three CTs per site.

Table 9.4 Meter inspection and testing program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Whole current	5	1,028	1,028	1,028	1,028	1,028	1,028
LVCT	20	82	82	82	82	82	82
HVCT	1	26	26	26	26	26	26

Table 9.5 Meter inspection and testing program – Non-regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Whole current	5	255	255	255	255	255	255
LVCT	4	87	87	87	87	87	87
HVCT	5	0	0	0	0	0	0

Table 9.6 LVCT and HVCT inspection and testing program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
LVCT	68	68	68	68	68	68	68
HVCT	0	40	40	40	40	40	40

Note: testing to commence in 2018-2019 financial year

Table 9.7 LVCT and HVCT inspection and testing program – Non-regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
LVCT	2	20	20	20	20	20	20
HVCT	0	0	0	0	0	0	0

Note: testing to commence in 2018-2019 financial year

Table 9.8 Annual audit - Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Audit	1	1	1	1	1	1	1

9.3 Prepaid meters replacement program

9.3.1 Overview

All existing prepaid token card meters in the regulated networks are to be replaced[3], as the manufacturer of existing meters (AMPY) no longer supports the token card meters.

9.3.2 Issues and options

The option to source alternative token based meters is not feasible as they are no longer manufactured. Type 4 meters with disconnect capability are the preferred replacement type.

Power and Water is currently trialling the [redacted] for its prepaid meter solution[4]. The [redacted] meter is a Type 4 meter with an inbuilt disconnect relay. The vending of the meter and any changes to future programming of the meter are done remotely. The meter can be used as credit or prepaid as required.

The weighted average age of Power and Water's prepaid meters is 10.4 years from date of the installations with the oldest meter being 18 years compared to an expected life of 15 years. As the token card meters are no longer manufactured; and the strong preference to provide and manage a single prepayment solution, the replacement of all existing prepaid meters as soon as practical is preferred.

A single solution is preferred due to the benefits and efficiencies gained from simplified:

- Retail vending solution;
- Customer education; and
- Asset management.

9.3.3 Asset management plan

There are approximately 3,378 prepaid meters within the regulated asset base as detailed in Table 9.9 and this plan makes provision for replacement of these meters by 1 July 2019. The roll out of prepaid meters to IES communities (non-regulated) is not covered under this plan.

The ongoing replacement of and additional installation of prepayment meters

3 Prepaid meters in the non-regulated networks are also being replaced by IES as a separate program, not covered by this plan.

4 Meter selection was the result of extensive research into available prepaid meter technology in the market. There were only two viable solutions in the market. The alternate solution to [redacted] meters is currently used by IES. [redacted] It must be noted that, IES solution was the only viable option available in the market at the time.

Table 9.9 Families of prepayment meters to be replaced – Regulated networks

Whole current meter	Installation year	Number	Configuration
[redacted]	2000	12	1P1E
[redacted]	2000	329	1P1E
[redacted]	2001	1	3P3E
[redacted]	2006	65	1P1E
[redacted]	2006	541	1P1E
[redacted]	2009	248	1P1E
[redacted]	2009	2183	1P1E

9.10 Prepayment meter replacement program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Prepayment meters	[redacted]	[redacted]	0	0	0	0	0

9.4 Interval meter roll-out program (40-750MWh)

9.4.1 Overview

The interval meter roll-out program is an existing program implemented in 2016 to replace all existing accumulation meters (Type 6) for customers consuming 40 MWh – 750 MWh p.a. (CT connected and whole current) in Power and Water's regulated networks with interval meters. This program was approved 2014 Network Price Determination. It supports retailer competition and improved meter data for our larger customers.

9.4.2 Issues and options

No issues are being experienced.

9.4.3 Asset management plan

The program is due to be completed in June 2019. Approximately [redacted] meters of the identified [redacted] meters are still to be changed.

Table 9.11 Interval meter roll out program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Interval meter roll out	500	500	0	0	0	0	0

9.5 Meters at end of life replacement program

9.5.1 Overview

Small meter families that are identified as having failed as part of the annual meter test are scheduled for replacement in the subsequent year's replacement plan.

Large meter families that are identified as having failed as part of the annual meter test are scheduled for replacement across one or more annual meter replacement programs. The replacement program is prioritised to address the critical issues such as safety, percentage of the errors, polyphase or single phase and large consumption sites. The recovery of costs associated with large family failures will be negotiated with the AER and have not been incorporated in replacement forecasts.

Additionally, failures and faults that occur in individual meters will result in the individual meter being replaced.

9.5.2 Issues and options

When a meter family size is too small for sample testing, the cost of testing each meter exceeds the replacement cost and continued testing is not a viable option. Currently, meter families of 8 or less are scheduled for replacement.

9.5.3 Asset management plan

Forecast volumes for end of life meter replacements are based on trends for each meter type. Table 9.12 shows the basis of the forecasts. Additionally, it is expected that about 2% of the metering fleet not in the end of life forecast will fail in-service and require replacement or will be subject to a change in customer preference.

Table 9.12 End of life program – basis of forecast

Item	Basis of forecast
[redacted]	[redacted]

Item	Basis of forecast
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

Table 9.13 End of life replacement program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
End of life replacement – fail accuracy test	297	1,641	1,616	1,387	744	746	862
Faults and failures	89	138	211	285	361	438	512

No estimates have been made for end of life replacements in the non-regulated networks.

9.6 Additions and alterations program

9.6.1 Overview

Some existing meters require replacement each year because of additions and alterations to customers' electrical installations.

9.6.2 Issues and options

Replacement metering is as per new metering.

9.6.3 Asset management plan

Forecast volumes for other meter replacements are based on historic trends at about 670 pa.

Table 9.14 Additions and alterations meter replacements program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Other meter replacements	670	670	670	670	670	670	670

No estimates have been made for additions and alterations in the non-regulated networks.

9.7 Other meter replacements program

9.7.1 Overview

Some existing meters require replacement each year because of obsolescence and other reasons.

9.7.2 Issues and options

Replacement metering is as per new metering.

9.7.3 Asset management plan

Forecast volumes for other meter replacements are based on trends for each meter type. Table 9.15 shows the basis of the forecasts.

Table 9.15 Other meter replacements program – basis of forecast

Item	Basis of forecast
Accumulation Meter - Three Phase - Bottom connected – Various electronic and induction disk	Expected obsolescence from FY20 (excludes meters being replaced as a part of the Interval Meter Removal Program due for completion in FY19)
Accumulation Meter - Single Phase - Bottom connected – Various electronic	Expected obsolescence from FY18
Accumulation Meter - Single Phase - Bottom connected [redacted]	Historic rate (15 pa)
Accumulation Meter - Single Phase – Plug in [redacted]	Expected obsolescence from FY20
Accumulation Meter - Single Phase - Bottom connected – Various	Historic rate (21 pa)
Accumulation Meter - Single Phase - Plug in – Various induction disk	Expected changes increasing from FY18 to FY 25 as customers take up tariff changes
Accumulation Meter - Single Phase - Plug in – Various electronic	Expected obsolescence in FY18
Accumulation Meter - Three phase - Bottom connected - Various HV or LV electronic	Fleet consists of 1 meter only - expected obsolescence in FY18
Accumulation Meter - Three phase - Bottom connected - Various HV or LV induction disk	Fleet consists of 8 meters only - expected obsolescence in FY18
Accumulation Meter - Three phase - Plug in - Various HV or LV	Historic rate (36 pa)

Table 9.16 Other meter replacements program – Regulated networks

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Other meter replacements	1,048	1,151	1,975	2,204	2,847	2,845	2,729

No estimates have been made for other meter replacements in the non-regulated networks.

9.8 Meter abolishment

9.8.1 Overview

Some existing meters require abolishment each year because of alterations to customers' electrical installations. Meters are not reused.

9.8.2 Issues and options

No issues are being experienced.

Department of Housing has advised that there may be as many as 50 houses to be abolished in the southern region in the next 5 years as result of rebuilding new homes under a project. It would be prudent to allow a half of this - an additional 25 meters abolishment in the period FY19 to FY22 – in the forecast plan.

9.8.3 Asset management plan

The forecast meter abolishment associated with this plan is shown in Table 9.17.

Table 9.17 Meter Abolishment

Item	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Meter Abolishment	5	12	12	12	12	5	5

10 Investment program

The investment program is developed based on the:

- Continuation of the established lifecycle asset management approaches – discussed in Appendix B;
- Specific requirements related to growth in the asset class – outlined in Section 8; and
- Specific requirements related to renewal and maintenance of the asset class – outlined in Section 9.

10.1Capital expenditure (capex)

10.1.1 Unit rates

Unit rates have been established from current contracts. Table 10.1 shows the rates for currently purchased meters.

Table 10.1 Metering - Unit costs ($, real 2017-18) (commercial-in-confidence)

Item	Meter cost	Installation	Unit cost
Advanced Meter - Single Phase - Plug in – Various	[redacted]	[redacted]	[redacted]
Advanced Meter - Single Phase - Bottom connected [redacted]	[redacted]	[redacted]	[redacted]
Advanced Meter - Single Phase - Plug in – [redacted]	[redacted]	[redacted]	[redacted]
Advanced Meter - Three Phase - Bottom connected – [redacted]	[redacted]	[redacted]	[redacted]
Advanced Meter - Three Phase - Bottom connected - [redacted]	[redacted]	[redacted]	[redacted]

10.1.2 Augmentation expenditure (augex)

Augmentation (growth) related investment in the metering asset class has been identified for the short and medium term as shown in Table 10.2.

Table 10.2: Metering - Augmentation expenditure forecast ($, real 2017-18)

Program	Unit	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Total FY20-24
New connections	Volume	495	612	864	1,028	1,050	514	520	**3,976**
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

10.1.3 Renewal expenditure (repex)

Replacement related investment in the metering asset class has been identified for the short and medium terms as shown in Table 10.3.

Table 10.3: Metering - Replacement expenditure forecast – regulated networks ($, real 2017-18)

Program	Unit	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Total FY20-24
Prepaid	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Interval 40-750 MWh pa	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
End of life replacement	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Faults and failures	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Adds and Alterations	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Other replacements	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	Volume	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

10.2Operational expenditure (opex)

10.2.1 Unit rates

The unit rate for forecasting of costs in the regulated networks is based on an average of internal labour rates. No estimates have been made for costs in the non-regulated networks.

10.2.2 Forecast expenditures

The operating expenditure forecast for metering assets for the short and medium terms is provided in Table 10.4 and Table 10.5.

Table 10.4 Metering – Opex forecast – Regulated networks ($, real 2017-18)

Program	Unit	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Total FY20-24
Inspection and testing	Volume	94	1,244	1,244	1,244	1,244	1,244	1,244	6,220
Annual audit	Volume	-	1	1	1	1	1	1	**5**
TOTAL	Cost ($ m)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Note: Costs include the Darwin Metering Laboratory

Table 10.5 Metering – Opex forecast – Non-regulated networks ($, real 2017-18)

Program	Unit	FY18	FY19	FY20	FY21	FY22	FY23	FY24	Total FY20-24
Inspection and testing	Volume	16	362	362	362	362	362	362	1,810
	Cost ($ m)	na	na	na	na	na	na	na	na

Note: No estimates have been made for opex in the non-regulated networks.

11 Asset class outcomes

11.1Key performance indicators

11.1.1 Reliability indicators

No reliability indicators apply to the metering asset class.

11.1.2 Responsibility indicators

Implementation of this asset management plan is expected to result in the responsibility outcomes shown in Table 7.1.

Table 11.1: Responsivity indicators, targets and expected outcomes

Indicator	Description	Target	Expected outcome
Number of safety incidents	Near misses, injuries, fatalities, etc.	Zero	Zero
Audit of metering installation testing	Random audit of accuracy requirements of each individual component plus the overall error of the installation	100% of random audits completed	100% of random audits completed
Compliance with Chapter 7A of the NER*	Monthly reporting by exception	100% compliance	100% compliance

Note: * Chapter 7A to commence from July 2019

11.1.3 Sustainability indicators

No sustainability indicators apply to the metering asset class.

11.2Leading indicators

A potential key leading indicator for metering is asset age for specific metering assets. Work to develop a leading indicator has not yet commenced.

12 Performance monitoring and improvement

Ongoing condition and performance monitoring is a key part of Power and Water's performance evaluation and improvement strategy. Study of the condition and performance data captured over time assists in developing valuable insights on underground cable defect modes and trends. These insights provide for informed decision making on whether to repair or replace cable assets. It assists in the continuous development of the asset management strategy for metering assets.

Table 12.1 details the performance measures, requirements to improve performance monitoring, and assigns responsibilities. The tasks are primarily derived from the asset lifecycle management activities discussed in Appendix B.

Table 12.1: Performance measures

Criteria	Measured attribute	Target	Current performance	Gap	Improvement requirements	Improvement responsibilities
Public and Worker Safety including equipment safety	Neutral Integrity Testing	100%	Only carried out on new installations. For existing installations the status is "Unknown"	Not known	Smart meter as new and Replacement policy	Metering Services Manager
	Polarity testing	100%	100% Compliant	Nil	Ensure the existing policies and commissioning checks contains such requirements	Metering Services Manager
	Phase rotation	100%	There is no standard phase rotation for the existing installations. The rotation is based on the wiring arrangements on customer installations.	Power and Water set out policies for all new installations to be forward rotation. The existing installations to be verified and the meters are connected in accordance to the existing phase rotation.	Phase rotation is included in the commissioning sheet	Metering services Manager and Power and Water Engineering standards
	Meter installation testing and inspection	100%	Work procedure are available for testing	Not conforming with procedures	Tool box meeting and regular training	Metering services manager and metering works coordinator
	Skill and training	100%	Continuous training of new technology.			
Compliance	Pattern Approval	All new meters purchased to have	100% compliant. Power and Water does not procure	N/a	Nil	Metering Service Manager

		pattern approval	meters without pattern approval			
	Accuracy testing	Testing in accordance to Chapter 7A / or Metering AMP	No testing has commenced	No testing has commenced	Testing to commence in 2018. Additional allocation of resources for this task.	Metering Services Manager
	Metering Installation inspection	Inspection in accordance to Chapter 7A or asset management plan	50% of CT connected meters has been inspected. No testing has commenced	Continue with inspection of the remaining metering assets	Inspection to commence in 2018. Additional resource allocation for this task.	Metering Services Manager
	Design	Design a secure, practical and compliant metering scheme	All new designs are compliant with the Rules requirements	Some existing design are not compliant with the rules requirements	Seek derogation or transitional arrangements for existing design. Provision of errors compensation in the meters.	Metering Services Manager
Data security and accuracy	The security of the metering data is compliant with Chapter 7A of the National electricity rules	To ensure meters have appropriate password and security control processes in place to ensure that energy data held in the metering installation is protected from direct local or remote electronic access.	100% Compliant	NIL	N/A	Metering Services Manager

13 Appendix A – Interfacing systems, document hierarchy, and related documents

Documents relevant to this AMP are as follows:

1. NT Chapter 7A of the National Electricity Rules version 88, S7A.2.1.2 – requires testing and inspection to be in accordance with an approved Asset Management Strategy.

2. AEMO, Service Level Procedure: Metering Provider Services Category B for Meter Installation Type 1, 2, 3, 4, 5 and 6 – Section 4.19.1 requires that "the Metering Provider must develop, maintain and execute a Metering Asset Management Plan for all metering installation assets for which the Metering Provider has been engaged to provide maintenance and testing services by the responsible person, which is to be approved by AEMO".

3. AEMO, Metrology Procedure Part A – Section 2 covers the installation and testing of meters. Section 2.7 requires an Asset Management Test Plan for maintaining and inspecting meters to be submitted to AEMO for approval.

4. NT Chapter 7A – Schedule 7A.3.1 – requires that a meter installation is provided, installed and maintained in accordance with the Rules.

5. Power Networks Network Technical Code and Network Planning Criteria – Version 3.1 (September 2013) – Section 10.5 requires Power and Water to maintain a metering register of all users revenue metering installations that provide tariff data. The requirement to maintain a meter register is also included in Clause S 7.1.2 of Chapter 7 of the National Electricity Rules.
6. Power Networks Technical Code – version 3.1 (September 2013 – Table A4.1 describes the overall accuracy requirements for Revenue metering Installations. The requirements for the overall accuracy requirements are also included in the Table 7A1.1.1 of chapter 7A of the NT Rules.

7. Electricity Retail Supply Code.

8. https://dpti.sa.gov.au/ data/assets/pdf file/0004/292477/Strategic Asset Management Framework.pdf

9. Power and Water, 2017, BNI metering – new and replacement expenditure

Australian Standards, IEC and other related guidelines relevant to this AMP:

1. Wiring Rules - AS/NZS3000:2007
2. Meters - AS1284.1, AS1284.10.2, AS 62052.11-, AS 62052.21, AS62053.21, AS 62053.22, AS 62054.11, AS 62054.21, AS 62056.21
3. Current Transformers - AS1675 - 1986, AS60044.1, AS 60044.3, IEC 61869-1, IEC 61869-2
4. Voltage Transformers - AS1243 - 1982, AS60044:2, AS 60044.3, AS 60044.5, IEC 61869-3
5. Sample Testing - AS 1284.13, AS1199, AS2490
6. AEMO, Sample Testing – AEMO, Alternate Testing Minimum Requirements - Low Voltage Current Transformer Metering Installations

14 Appendix B – Lifecycle asset management

14.1Planning (augmentation)

No planning requirements apply.

14.2Design

All new metering equipment shall comply with Chapter 7A of the National Electricity Rules, National Measurement Act 1960 and its subordinate procedures under National Measurement Institute.

Power and Water is responsible for the design of the metering scheme. The designs are in accordance with the Metering Manual. All non-standard design approved by the Senior Metering Services Manager.

14.3Operation

The collection of metering data is not covered by this plan.

14.4Maintenance (opex)

Meters and meter auxiliaries do not require routine maintenance for their correct operation. Inspection and testing requirements are set out below.

A General metering

“In service” compliance testing shall be used to assess the accuracy of meters and meter auxiliaries. Sample testing using sampling by attributes to AS 1284.13 will be undertaken for meter family populations > 8. Smaller families shall be replaced.

If a meter sub-population is found to have failed sample testing, it will be scheduled for replacement in the subsequent annual meter replacement program(s). Sign-off authority for this to occur must involve the Senior Metering Services Manager and the Meter Laboratory Senior Technical Coordinator. The replacement of large meter families may take one or more years to achieve and will require additional field resources.

If a small family is found to have failed sample testing (families of meters less than 8), the family will be scheduled for replacement as part of the subsequent year's meter replacement program.

B HV metering

Power and Water is responsible for testing and inspection of HV instrument Transformers within the Power and Water networks. VTs are normally purchased as part of the project and not on a volume basis. There are several varieties and types of VTs in service which are not categorised into logical populations for sample testing. As for HV CTs, these are purchased as part of the switchgear and cannot once again be categorised into a logical population.

Due to the energy throughput in HV connections, Power and Water has implemented a testing program based on a ten year cycle of its 100% populations for all its HV CTs and VTs as prescribed under Chapter7A of the Rules. Where the secondary injection test is not logistically a viable option, the testing will be outsourced to a NATA registered test service to undertake the primary injection test.

14.5Renewal (repex)

Meter replacement is not undertaken on a like for like basis.

All replacement domestic installations are of type 4 smart meters with disconnect relays and capability of registering import and export energy. Where there is no telecommunication network available, Power and Water will continue to install smart ready meter that are upgradeable with the addition of an optional telecommunication module. These meters will be programmed as type 6 metering installations.

Where metering on asbestos boards is replaced or modified, the following practices are adopted:

- Power and Water has a number of 3x single phase meters in lieu of the polyphase meters. If these meters are found to have been installed on asbestos boards, Power and Water maintains the same arrangements, as the cost of the conversion to a polyphase meter can be safely deferred.
- For single phase meters on plug in arrangements that are mounted on asbestos boards, Power and Water will unplug the old meter and plug in the new meter. The asbestos board is not disturbed.
- For all three phase meters (bottom connects) on asbestos boards, both the board and meter are replaced.
- For all single phase meters (bottom connects) both the board and meter are replaced.

Replacement of other metering types shall be consistent with the standards for new metering.

14.6Disposal

No specific disposal requirements apply.

15 Appendix C – Option evaluations decision criteria

15.1Investment decision making

Risk analysis is an integral part of the decision-making process. To balance competing drivers such as network performance versus cost, contemporary asset management practice applies risk and value based decision-making frameworks. This ensures that investment decisions are made as consistently as possible, and balance the organisation's objective to deliver a safe, reliable and affordable network.

Investment decisions principally revolve around three matters: "what" needs to be done; "how" does it need to be done; and, "when" does it need to be done.

The "what" requires the clear and precise identification of the need for and investment. For example, this may be associated with an identified capacity constraint or an asset in poor condition and becoming increasingly likely to fail. Correctly defining the need is crucial to identifying the most prudent and efficient solution. For example, a capacity constraint should not be identified as a need to augment, but rather a need to relieve the constraint. This allows for the appropriate and full consideration of all feasible options for meeting the need – that is, the "how".

Deciding on the "how" requires comprehensive analysis of all reasonably practicable options to meet the need. Ceteris paribus, the life-cycle cost of each option is the central determinant of the most likely option to be successful in the evaluation of all options to meet the need. That is, the option with the lowest life-cycle cost that meets the need is the most likely option to be selected.

The final matter to determine in the decision-making process is "when" the investment needs to be made. Both premature and belated investment introduces unintended consequences, such as a lack of available capital to mitigate higher risks, or the manifestation of undesirable performance or safety consequences. Determining the correct timing requires an understanding and consideration of how the risk changes over time.

15.2NER Context for making decisions on risk

The National Electricity Rules (NER) provide guidance in terms of setting acceptable risk and expenditure trade-offs via the capital and operating expenditure objectives and criteria for standard control services. These capital and operating expenditure objectives, specified in clause 6.5.6(a) and 6.5.7(a) of the NER describe the outcomes or outputs to be achieved by the expenditure. The objectives include:

1. Meet or manage the expected demand for standard control services;
2. Comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;
3. To the extent that there is no applicable regulatory obligation or requirement in relation to the quality, reliability or security of supply of standard control services; or the reliability or security of the distribution system through the supply of standard control services, to the relevant extent:
    a) Maintain the quality, reliability and security of supply of standard control services

b) Maintain the reliability and security of the distribution system through the supply of standard control services

4. Maintain the safety of the distribution system through the supply of standard control services.

The objectives effectively require a DNSP to forecast its expenditure at levels which achieves a risk level that meets regulatory or legislative requirements, and where these requirements do not exist, sufficient to maintain the existing risk profile.

To objectively maintain the risk profile over time, Power and Water has developed an asset health and criticality framework.

15.3Health and criticality

The health and criticality framework and methodology support the decision-making process for investments required on existing assets by identifying the need for investment, together with the timing of when the investment is most likely to be required. The options (i.e. the "how") is addressed separately from the framework to ensure that there is apposite consideration of all reasonably practicable options that could address the need.

The health and criticality methodology support the decision-making process by providing a perspective on the risk within an asset group. The addition of a value framework to the health and criticality framework allows consideration and comparison of risks between asset classes. This allows for investment decision-making to be prioritised towards those assets and issues that comprise the greatest risk on the network.

A key attribute of risk and value based decision-making framework is the adoption of a consistent and comparative method for assessing assets and risks. The health and criticality framework is used to determine "asset indices" that describe each asset for the purposes of risk prioritisation. Asset indices allow the performance (or risk) of assets to be monitored over time, and when required, investment programmes to be developed that target and prioritise investment towards those assets that exhibit a level of risk that is increasing (or already intolerable), so that overall risk levels can be maintained.

The "DNO Common Network Asset Indices Methodology" developed by the UK Distribution Network Operators (UK DNO) and approved by the UK Regulator, Ofgem, is one such methodology that defines the framework, principles and approach to assessing assets and determining asset risk. One aspect of the UK DNO methodology is that whilst it is comprehensive, it is also exceptionally data intensive, and time consuming to develop, implement and maintain.

As significant value can be gained in the decision-making process from the insights gained through a robust health and criticality framework, Power and Water appropriated many key features of the UK methodology whilst seeking to balance the benefits with the time, cost and data availability required to define all possible asset characteristics. Power and Water's methodology is used to monitor asset risk over time so that decisions can be made about what needs to be done, and when the actions are required, such that risk levels can be maintained.

The two critical features embraced by both the UK DNO and Power and Water frameworks are the attribution of concepts of "health" and "criticality" to an asset.

Asset Health

Asset health is a measure of the useful remaining life of an asset. The poorer the health of an asset, the nearer it is to the end of its life, and thus, the more likely it is to fail.

To account for the deterioration of assets over time (i.e. time-based degradation that is exhibited by all physical electricity network infrastructure), the age of the asset forms the basis of asset health. The asset health attribute is modified by applying factors that correct for observed and monitored conditions. For example, factors such as the results from recent condition based inspections, location and duty are considered to determine an asset's conditional age. The conditional age is then compared to the assets expected life (generally derived from a combination of historical and industry data) to determine the asset's remaining life.

A three-point health index scale is used to categorise assets in terms of their expected remaining life:

- H1 indicates assets with more than 15 years of expected life remaining. These assets present a very low probability of failure given they are assessed as being in a good condition.
- H2 indicates assets with between 5 and 15 years of expected life remaining. These assets present a low probability of failure given they are assessed as being in a reasonable state of deterioration.
- H3 indicates assets with 5 or less years of expected life remaining. These assets present a reasonable probability of failure given their condition is assessed as poor or very poor.

Asset Criticality

The failure of an asset results in a consequence. For example, this could range from a localised loss of supply, to a wide scale outage, or a near miss incident to the fatality of a network worker or member of the public. The severity of the consequence is dependent on the criticality of the asset. For example, assets supplying critical infrastructure (hospitals, water treatment plants, data centres) are more critical than asset supplying residential dwellings. Likewise, from a safety risk perspective, assets in high density areas (e.g. CBD, shopping centres) are considered more critical than those in less dense areas (e.g. rural).

The assumptions and inputs used to evaluate the health and criticality for each asset class are detailed in the respective Asset Management Plan.

16 Appendix D – Failure Mode Analysis and Maintenance Frequency

No routine maintenance of metering assets is undertaken. Failure modes and consequences are set out in Table 16.1.

Table 16.1: Metering - Failure modes and consequences

Description	Consequence
Electromechanical Meters – demagnetising of disk	Meter runs faster and potential overcharging of customer
Electromechanical Meters – wear of pivot points	Meter runs slower and potential undercharging of customer
Electronic Meters – aging or failure of electronic components	Inaccurate metering or failure
Overheating of terminal connections	High impedance leading to flicker and/or fire

17 Appendix E – Meter families

The families established for managing inspection and testing is shown in the following tables. The tables also show the testing methodology and details of the sample testing required based on

The current asset condition

Table 17.1 Meter families – regulated networks

Whole Current Meter	WC/LVCT/HV	Installation Year	Number of Meters	Config	North	South	Sample test Y / N	Method Attribute /	Standard the family	North Sample tested	South Sample tested
M2	WC	1981	5840	1P1E	4,746	1,094	Y	Attribute	AS1284.13	200	80
DB43B	WC	1984	8	3P3E	6	2	Y	Attribute	AS1284.13	2	2
[redacted]	WC	1985	1084	3P3E	891	193	Y	Attribute	AS1284.13	80	20
	WC	1986	731	1P1E	668	63	Y	Attribute	AS1284.13	80	13
	WC	1986	17590	1P1E	13,113	4,477	Y	Attribute	AS1284.13	315	200
	WC	1989	411	1P1E	107	304	Y	Attribute	AS1284.13	20	50
	WC	1993	5140	1P1E	3,879	1,261	Y	Attribute	AS1284.13	200	125
	WC	2001	24	3P3E	23	1	Y	Attribute	AS1284.13	5	Replace
	WC	2001	42388	1P1E	38,168	4,220	Y	Attribute	AS1284.13	500	200
	WC	2005	3,270	1P1E	2,679	591	Y	Attribute	AS1284.13	125	80
	WC	2010	975	1P1E	975	0	Y	Attribute	AS1284.13	80	N/A
	WC	2010	115	1P1E	110	5	Y	Attribute	N/A	20	Replace
	WC	2010	1405	1P1E	1,391	14	Y	Attribute	AS1284.13	125	3
	WC	2010	1884	3P3E	1,594	290	Y	Attribute	AS1284.13	125	50
	WC	2010	6048	1P1E	4,720	1,328	Y	Attribute	AS1284.13	200	125
	WC	2011	1787	3P3E	1,400	387	Y	Attribute	AS1284.13	125	50
	WC	2011	4055	1P1E	3,722	333	Y	Attribute	AS1284.13	200	50
	WC	2011	1285	3P3E	1,128	157	Y	Attribute	AS1284.13	80	32
	WC	2011	2667	1P2E	1,748	919	Y	Attribute	AS1284.13	125	80
	WC	2013	4726	1P1E	4,592	134	Y	Attribute	AS1284.13	200	20
	WC	2013	566	1P1E	566	0	Y	Attribute	AS1284.13	80	N/A
	WC	2016	158	1P1E	158	0	Y	Attribute	AS1284.13	32	N/A
	WC	2016	69	1P1E	69	0	Y	Attribute	AS1284.13	13	N/A
	LVCT	1988	182	3P3E	153	29	Y	N	AEMO	153	29
	LVCT	2009-20xx	227	3P3E	126	101	Y	N	AEMO	126	101
	HV	2009	2	3P3E	2	0	N	N/A	Chapter7A	2	N/A
	HV	2012-2016	73	3P3E	62	11	N	N/A	Chapter7A	62	11
	HV	2015-2017	19	3P3E	19	0	N	N/A	Chapter7A	19	N/A
	HV	2015-2016	2	3P3E	2	0	N	N/A	Chapter7A	2	N/A
	HV	2016-2017	33	3P3E	25	8	N	N/A	Chapter7A	25	8
			102,764	0	86,842	15,922	0	0	0	3,321	1,329

Note: The number of meter families is based on information from MAXIMO, RMS and MV90 as of 13/6/2017

Table 17.1 Meter families – non-regulated networks

Whole Current Meter	WC/LVCT/ HV	Installation Year	Number of Meters	Config	North	South	Sample test Y / N	Method Attribute / Variable	Standard the family tested	North sample tested	South Sample Tested
	WC	1985	324	3P3E	321	3	Y	Attribute	Replace	50	Replace
	WC	1986	1548	1P1E	876	672	Y	Attribute	AS1284.13	80	80
	WC	1989	378	1P1E	374	4	Y	Attribute	Replace	50	Replace
	WC	1993	510	1P1E	284	226	Y	Attribute	AS1284.13	50	32
	WC	2000	114	1P1E	5	109	Y	Replace	AS1284.13	Replace	20
	WC	2001	4009	1P1E	2837	1172	Y	Attribute	AS1284.13	125	80
	WC	2005	332	1P1E	106	226	Y	Attribute	AS1284.13	20	32
	WC	2009	2480	1P1E	1167	1313	Y	Attribute	AS1284.13	80	125
	WC	2010	70	3P3E	32	38	Y	Attribute	AS1284.13	8	8
	WC	2010	86	1P1E	64	22	Y	Attribute	AS1284.13	13	Replace
	WC	2011	211	1P1E	176	35	Y	Attribute	AS1284.13	32	8
	WC	2013	2269	1P1E	2261	8	Y	Attribute	AS1284.13	125	Replace
	LVCT	1985	33	3P3E	26	7	Y	N/A	AEMO	26	Replace
	LVCT	1988	182	3P3E	153	29	Y	N/A	AEMO	153	29
	LVCT	2009-20xx	227	3P3E	126	101	Y	N/A	AEMO	126	101
Total Whole Current Meters			12,773		8,808	3,965				938	515

Note: The number of meter families is based on information from MAXIMO and MV90 as of 13/6/2017

Table 17.2 LVCT families – Regulated networks

CT Meter Model	Installation year	Number of Current Transformers	Configuration	North	South	North Number of Sites to be tested	South Number of Sites to be tested
	1981	66	3P3E	21	1	5	1
	2000	24	3P3E	5	3	2	2
	1985	220	1P1E	151	69	32	13
	1985	7	1P1E	7	0	2	0
	1988	574	1P1E	430	144	50	20
	1999	9	3P3E	0	3	0	2
	2000	21	3P3E	3	4	2	2
	2002	0	3P3E	0	0	0	0
	2004	51	3P3E	16	1	5	1
	2009-20xx	6021	3P3E	1651	356	125	50
Totals		6993		2284	581	223	91
Number of sites to be tetsed every year						**223**	**91**

Note: The number of families is based on information from MAXIMO and MV90 as of 13/6/2017

Table 17.3 LVCT families – Non-regulated networks

CT Meter Model	Installation year	Number of Current Transformers	Configuration	North	South	North Number of sites to be testedtest	South Number of sites to be testedtest
[redacted]	1981	3	3P3E	2	0	2	0
	2000	18	3P3E	5	1	2	1
	1985	33	1P1E	26	7	8	2
	1985	3	1P1E	3	0	2	0
	1988	182	1P1E	153	29	32	5
	1999	0	3P3E	0	0	0	0
	2000	0	3P3E	0	0	0	0
	2002	0	3P3E	0	0	0	0
	2004	3	3P3E	1	0	1	0
	2009-20xx	681	3P3E	126	101	20	20
Totals		**923**		**316**	**138**	**67**	**28**
Number of sites to be tested every year						**67**	**28**

Note: The number of families is based on information from MAXIMO and MV90 as of 13/6/2017

Table 17.4 HVCT families – Regulated networks

VT Meter Model	Installation Year	HV meter Installations	No. of VT's	No. of CT's	Configuration	North	South	Number of CT sites tested North	Number of CT sites tested South	Number of VT sites tested North	Number of VT sites tested South
[redacted]	2001	0	0	0	3PH 3ELEMENT	0	0	0	0	0	0
	2005	0	0	0	3PH 3ELEMENT	0	0	0	0	0	0
	2009	2	2	6	3PH 3ELEMENT	2	0	2	0	2	0
	2012-2016	73	73	219	3PH 3ELEMENT	73	0	62	11	62	11
	2015-2017	19	19	57	3PH 3ELEMENT	19	0	19	0	19	0
	2015-2016	2	2	6	3PH 3ELEMENT	2	0	2	0	2	0
	2016-2017	33	33	99	3PH 3ELEMENT	25	8	25	8	25	8
Total HV Metering Installations		129	129	387		121	8	110	19	110	19
Number of CT and VT tested every year								**13**	**0**	**11**	**2**

Notes: The number of families is based on information from MAXIMO and MV90 as of 13/6/2017.

There are no HV metering installations in non-regulated networks.

18 Appendix F – Strategy for testing and inspection of the meter families

The purpose of this section is to introduce the preferred testing methodologies, including time based inspection that differs from the requirements of Chapter 7A of the Rules. These include but are not limited to:

- Timely sampling, testing, and assessment of in-service compliance of populations of electricity meters in accordance with AS 1284.13
- Timely sampling, testing, and assessment of in-service Low Voltage Current Transformers in accordance to AEMO guidelines "Alternate Testing Minimum Requirements - Low Voltage Current Transformer Metering Installations"
- Inspection and testing of metering installations based on time based inspection outlined in Chapter 7A of the rules where practical.

The reasons for these changes are set out below.

18.1 Proposed testing methodology of the Power and Water's meter families for regulated and non-regulated assets

"In service" compliance testing is an economical method of determining whether a population of electricity meters, installed in service for a number of years, is continuing to operate in accordance with the meter's metrological specifications.

Chapter 7A of the Rules further requires the Metering Coordinator (MC) to ensure that the equipment comprised in a purchased metering installation has been tested to the required class accuracy with less than the uncertainties set out in table S7A.2.1.1 of the Rules. Table 12 provides the summary of the test period as prescribed under the Chapter 7A of the Rules. This work may be performed either in the laboratory or in the field, as required.

Australian Standard AS 1284.13 also permits the sample testing of energy meters where the numbers installed make 100% compliance testing impractical. This standard prescribes a statistical approach with a sample of the family of meters to be tested for accuracy in accordance to clause 8.4 of the AS 1284.13 sample sizes and pass or fail levels shall be in accordance to table 4 and 5 of the AS1284.13.

Power and Water adopts the sampling methodology as prescribed under the AS1284.13 for all its Whole Current (WC) meters. This methodology only considers sampling by attributes, unless otherwise prescribed.

The decision to choose sampling by attributes is mainly due to the simplicity of this method. It requires fewer detailed records and is generally faster; hence the administration of inspection is easier. Once substantial data is collected and the normality of the test results is proven, it is proposed the inspection by variable method be adopted.

As for testing of LV CTs, in May 2012 AEMO published a document entitled 'Alternate Testing Minimum Requirements - Low Voltage Current Transformer Metering Installations', in an effort to gather sufficient CT failure data to permit a sample testing regime to be established. This process is still ongoing and in accordance with this document low voltage CTs can, for the

foreseeable future, be sample tested. Similar statistical processes are prescribed in this document to those used in AS1284.13.

Table 18.1 Maximum period between tests

Description	Metering installation type				
	Type 1	Type 2	Type 3	Type 4 & 4A	Type 5 & 6
CT	10 years	10 years	10 years	10 years	10 years
VT	10 years	10 years	10 years		na
Burden tests	When meters are tested				
CT connected meter (electronic)	5 years	5 years	5 years	5 years	5 years
CT connected meter (induction)	2.5 years	2.5 years	5 years	5 years	5 years
Whole current meter	The testing and inspection requirements must be in accordance with an approved asset management strategy. Note: The requirements in relation to approval of an asset management strategy for the purposes of this provision will be considered as part of the phased implementation of the Rules in this jurisdiction.				

As there are currently no statutory bodies responsible for the approval of the Metering Asset Management Strategy in the NT, the alternative testing methodology prescribed in this document is in line with industry practices operating in the National Electricity Market and the AEMO's guide for preparation of the Asset Management Plan.

The details of the testing methodology for each family of meters for both regulated and non-regulated meters are outlined in Table 13 and Table 15. Tables 14 and Table 16 also provide the summary of the number of meters to be tested each year.

Where the family of meters is too small (less than 8) and continued testing of these families is found to be financially unviable, the family of meters is to be replaced.

18.1.1 Type 1 and 2 Meters

Because of the very low number of Type 1 and 2 installations in the NT, each of these meters will be tested and inspected in accordance with S7A.2 of Chapter 7A of NT Rules.

18.1.2 Type 3 and 4 Meters

Under the requirements of 'Alternative Testing Minimum Requirements - Low Voltage Current Transformer Installations' it will be necessary to fully compliance test all Type 3 and 4 energy meters. This ensures that all Type 3 and 4 installations will be visited at least every five years and an enhanced site inspection will be undertaken at this time.

18.1.3 Type 6 Meters – there are no type 5 metering installations in the NT

Because of the large populations of whole current meters throughout the NT, a considerable benefit will be gained from sample testing the larger sub-populations (>8) in accordance with AS1284.13. As mentioned earlier, some whole current meters either exist in very small numbers or are very old, and in both cases they will be replaced rather than tested. (See Table 8.)

AS1284.13 describes two statistical methods (variables and attributes) for determining whether the failure rate of a sub-population of meters is acceptably low, based on the performance of the chosen sample.

The variables approach permits smaller sample sizes (≤8) but requires that the results be normally distributed in order to give a meaningful assessment. Normally distributed magnitude and phase errors are often difficult to obtain from small meter populations, as many other metering providers have discovered. For this reason Power and Water has decided to adopt the simpler attributes approach to meter sample testing.

Sub-populations will be drawn from the general CT population based on manufacturer, meter type, CT secondary current, burden and date of installation. The health of each sub-population will be assessed based on the performance of the sample, and in the unlikely event of failure, the entire sub-population must be replaced.

The re-test interval depends on the performance of the sub population in question. A well performing population may be granted an ongoing compliance period of up to 4 years, while a poor performing population, (one with a relatively high number of failures), may need to be retested in as little as 2 years. This standard also provides an initial compliance period of up to 8 years, depending upon how well a batch of new meters performs in initial testing which must be performed within three years of their being placed into service.

18.1.4 Small Family Failure Replacement Strategy

If a small family is found to have failed sample testing, the family will be scheduled for replacement as part of the subsequent year's meter replacement program.

18.1.5 Low Voltage Current Transformers

Due to the large number and difficulty in arranging the necessary outages for testing, Power and Water has chosen to implement the sample testing approach currently available to metering providers in the NEM, as described in the AEMO document ‘Alternative Testing Minimum Requirements - Low Voltage Current Transformer Installations' (2012). As in the case of energy meters, the attributes approach to error testing will also be used for CT testing.

There are likely to be some metering installations where very old current transformers are found to be in service. Where these are discovered they will be replaced with modern transformers of the same ratio (where there has not been a significant change in the load profile for that connection point), thereby reducing the number and age of different CTs in service.

Power and Water has also introduced the fleet of split core CTs at the inception of the market in the NT. These CTs are all compliant with the NEM requirements and are a significantly cheaper

option for establishing compliant metering in the NT. These CTs will be replaced on their 10 year anniversary in service.

18.1.6 High Voltage Current Transformers

HV CTs and associated Voltage Transformers (VT) will be fully compliance tested in accordance with Chapter 7A of the NT Rules. Testing will be performed in the field, every 10 years, in conjunction with the associated meter testing. There are only 129 HV metering installations in the NT (387 HV CTs and 129 VTs). An average of 13 HV installations will be tested each year, depending upon when the necessary outages can be arranged. The testing is proposed to be carried out by external resources.

18.2 Proposed inspection methodology of the Power and Water's meter families for regulated and non-regulated assets

Chapter 7A also requires that metering installations be inspected at the intervals defined in Table 3. For Types 1 and 2 in-service, inspection interval is 2.5 years.

Due to dynamic characteristics of the load and difficulties in monitoring the load, types 3, 4 and 6 metering installations for HV will be inspected every 3 years.

The AEMO document 'Alternate Testing Minimum Requirements - Low Voltage Current Transformer Metering Installations' mandates an enhanced inspection and data gathering process be implemented at sites where LV CT sample testing is carried out. It further stipulates that all Type 3, 4 and 6and 4 meters in LV installations be error tested. This means that current transformers and the meters in the same installation cannot both be the subject of sample testing.

In Line with the above document, LVCT connected meters for type 3, 4 and 6 metering installations, the inspection is proposed to be every 5 years. For types 4 & 6 whole current metering installations whenever the meter is tested.

Table 18.2 provides a summary of the metering Installation Inspection while Table 18.3 provides the metering installation inspection period proposed by Power and Water.

Table 18.2 Chapter 7A Requirements - Maximum period between Inspections

Meter Type	NER Table S7A.2.1.3	Resource (In-house /External)
Type 1	2.5 Years	In-house
Type 2	12 months (2.5 Years if check metering installed)	In-house
Type 3	>10GWh: 2 Years 2≤GWH≤10: 3 years <2GWh: When Meter tested.	In-house
Type 4	When Meter Tested	In-house
Type 4A*	Not Applicable	Not Applicable
Type 6	When Meter Tested	In-house

Table 18.3 Proposed Maximum period between Inspections by Power and Water

Meter Type	Power and Water Proposed	Resource (In-house /External)
Type 1	2.5 Years	In-house
Type 2	2.5 Years	In-house
Type 3 (HV)	3 years	In-house
Type 3 (LV)	When Meter Tested	In-house
Type 4 (HV)	3 years	In-house
Type 4 (LV)	When Meter Tested	In-house
Type 6 (HV)	3 years	In-house
Type 6 (LV)	When Meter Tested	In-house

18.3 Proposed testing and inspection of the HV metering installations (VT and CT) regulated and non-regulated assets

There are no HV metering installations within the non-regulated assets. For the regulated assets, Power and Water provides HV metering units (CTs and VTs) to customers under the Standard Control Services. This will however change in 1 July 2019 where the cost is recovered through Alternative Control Charges.

Power and Water is responsible for testing and inspection of HV instrument Transformers within the Power and Water networks. VTs are normally purchased as part of the project and not on a volume basis. There are several varieties and types of VTs in service which are not categorised into logical populations for sample testing. As for HV CTs, these are purchased as part of the switchgear and cannot once again be categorised into a logical population.

Due to the energy throughput in HV connections, Power and Water has implemented a testing program based on a ten-year cycle of its 100% populations for all its HV CTs and VTs as prescribed under Chapter7A of the Rules. Where the secondary injection test is not logistically a viable option, the testing will be outsourced to a NATA registered test service to undertake the primary injection test.

18.4 Proposed Testing of the Power and Water's HV installations (VT and CT) for regulated and non-regulated assets

Table 18.4 Summary HV CT and VT Test – Regulated

VT meter model	Installation year	No. HV meter installations	No. of VTs	No. of CTs	North	South	No. of CT sites tested North	No. of CT sites tested South	No. of VT sites tested North	No. of VT sites tested South
[redacted]	2001	0	0	0	0	0	0	0	0	0
	2005	0	0	0	0	0	0	0	0	0
	2009	2	2	6	2	0	2	0	2	0
	2012-2016	73	73	219	73	0	62	11	62	11
	2015-2017	19	19	57	19	0	19	0	19	0
	2015-2016	2	2	6	2	0	2	0	2	0
	2016-2017	33	33	99	25	8	25	8	25	8
Total HV metering installations		129	129	387	121	8	110	19	110	19
No. CT & VT tested each year							13	0	11	2

Note: All meters are three phase 3 element. There are no HV metering installations in the non-regulated assets.

Table 18.5 Summary HV CT and VT to be tested every year – Regulated and Non-Regulated

Total of HV CT Populations	Total Of VT	Total Of CT	Total of VT Test North	Total of VT Test South	North Test HV CT	South Test HV CT
129	129	387	121	8	363	24

Table 18.6 HV CT and VT to be tested – Regulated and Non-Regulated

Item	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26
Number of HV CT										
North	0	0	39	39	39	39	39	39	39	39
South	0	0	1	1	1	1	1	1	1	1
Number of VT										
North	0	0	12	12	12	12	12	12	12	12
South	0	0	1	1	1	1	1	1	1	1