



# Advanced Interval Meter Rollout (AIMRO)

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Point-to-Point GPRS Field Trials Report  
July-August 2007

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Commercial-in-Confidence

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### Trial Network

**100 Victorian households** metered utilising GPRS two-way communications.

**137** datastreams.

**6,576** ½- hour intervals daily.

### Technology Performance

**100%** of data remotely collected (no missing data).

**100%** of data accepted (no substitutions).

Meters successfully polled:

- **99.1%** by 5pm each day;
- **98.4%** by 8am each day;
- **92.8%** by 3am each day;
- **90.7%** by 12:15am each day.

Meter time synchronised to within **+/-5 seconds** of Australian Eastern Standard Time – 15 seconds better than required.

Meters **remotely reprogrammed** to:

- add new datastreams (eg. reactive energy); and
- change load control time-switch settings.

### MDA Performance

**100%** of data delivered to market participants within National Electricity Rule timeframes ready for energy trading, billing and settlements.

### Functionality

Special reads obtained in **20 seconds**.

Remote disconnections achieved in **5 seconds**.

Remote reconnections achieved in **6 seconds**.

Meters remotely re-armed in **6 seconds**.

Simultaneous **planned outage** (load control) successfully initiated by Retailers.

### Transfers

**Third party meter ownership allowed six** sites to successfully transfer to new Retailers:

- **no delay**; and
- **no meter churn**.



### Victorian Country Trial Sites



## Melbourne Metropolitan Trial Sites



**Single-phase residential smart meter with external modem power supply.**



**Single-phase smart meter – rural dam pump.**



**Single-phase residential smart meter – block of units.**



**Single-phase smart meter with external timeswitch.**



**GPRS base station – Airey's Inlet.**



**Three-phase residential smart meter.**

### Background & Purpose

Advanced Metering Infrastructure (AMI) – also known as "smart metering" – is a Victorian State Government coordinated project to install new interval meters with two-way communications capabilities for all Victorian electricity consumers.

Under the AMI project, about 2.4 million new AMI meters will be installed from 2008 to 2012 – aimed at helping Victorian electricity consumers better manage energy usage by providing detailed information about their consumption and the opportunities available to save money and reduce greenhouse gas emissions.

Invitation to participate in AMI working groups was extended by the State Government to licensed Victorian electricity Retailers and Distributors, which, under the National Electricity Rules, have "responsible person" status and, under the terms of their respective licenses, will ultimately be responsible for achieving the deployment of AMI across the State.

Representatives from electricity Retail and Distribution businesses have drafted minimum functional specifications for AMI and initiated technology trials to establish which metering and communications technologies best meet those requirements in the Victorian context.

### Scope of Trial

The purpose of this trial is to assess the performance and reliability of point-to-point General Packet Radio Service (GPRS) communication, metering and data system technologies across a range of market functions, thereby providing information to the industry on the availability of a commercial technology that supports the development of suitable functionality requirements for mass market Advanced Metering Infrastructure (AMI) deployment.

This trial is also a demonstration of how reliable and cost effective AMI solutions will be provided to Retailers through the current contestable market for meter provision and data management services.

The scope of the trial provides an opportunity for a detailed appraisal of the technical and operational merits of GPRS communication, metering, and data system technologies for comparison with the other technologies being trialled. The results of this GPRS trial will enable more objective and informed decisions to be made on how to proceed with an AMI roll out.

While it is recognised that the industry's current AMI project, including technology trials, are not intended to define a preferred technology, the sponsors of this trial believe that a demonstration of the merits of a currently available, commercial point-to-point technology will provide an important benchmark to inform policy decisions about minimum functionality, performance standards and deployment. The results of this trial should provide industry participants with a reference standard of current best practice from 'meter to market participant', delivered in a fully competitive market environment.

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Origin Energy, Red Energy and Victoria Electricity, in their role as Responsible Person under the Australian Electricity Rules (AER), have deployed approximately 100 remotely read interval meters utilising GPRS technology, in households located throughout Victoria<sup>1</sup>. They have also coordinated the conduct of a series of tests to demonstrate the application and performance of the communications channel and a range of meter functionalities.

Australian metering and data service providers currently have tens of thousands of interval meters installed, remotely read utilising GSM. Although GPRS utilises the same telecommunications platform as GSM, GSM is a dial-up legacy technology far less efficient and significantly more costly than GPRS. There may be a degree of confusion between the two technologies as only a limited number of competitive, innovative metering and data service providers currently have the know how and back end system capabilities necessary to exploit GPRS communications to its full potential.

The Department of Primary Industries has published a series of test scripts for field-testing the performance of AMI technologies, stating that “since most of the AMI trial systems that are being trialled do not have the full suite of functionality as specified in the Minimum State Wide Functionality Specification, these test scripts focus on testing communications performance rather than functionality”<sup>2</sup>.

Whilst proving the communications capabilities is a minimum requirement, the defined scope of the technology trials is inadequate to enable Retailers and other industry participants to make an effective and informed decision about the suitability of these technologies. Meter data management and other core AMI functions must be tested end-to-end in order to properly assess the capabilities that an AMI deployment will deliver to the market. Origin Energy, Red Energy and Victoria Electricity therefore decided to deploy a fully operational population of remotely read interval meters, 100% compliant with the strict technical standards and NEMMCO accredited data management performance levels contained within the National Electricity Rules.

Noting that the test scripts published by the Department of Primary Industries were focused largely on communications technologies, and Distributor Line Carrier (DLC) in particular, a series of revised performance and functionality test scripts were drafted for this trial to test:

- data collection capabilities;
- back-office Meter Data Agent functions, including the delivery of settlement ready data to NEMMCO and market participants; and
- retailer interaction with meters to:
  - obtain special reads;
  - disconnect and reconnect customers;
  - initiate load control; and
  - transfer customers.

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<sup>1</sup> Australian Power & Gas, Powerdirect and Momentum Energy are also acting as responsible person in this trial.

<sup>2</sup> AMI Technology Trials Test Scripts, Version 5.2, Department of Primary Industries, 22 February 2007 – page 3

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It is envisaged the trial will demonstrate these capabilities end-to-end within the strict compliance requirements of the national electricity market. It will also demonstrate that cost effective metering and data technologies providing high level reliability and functionality are currently available within the industry market place, allowing Retailers to operate their businesses effectively and develop products to meet policy and commercial objectives, now and into the future.

### **Scope of Report**

This document has been prepared by Origin Energy, Red Energy and Victoria Electricity, in conjunction with Metropolis Metering Assets Pty Ltd (Metropolis) and Centurion Metering Technologies Pty Ltd (Centurion), for the Department of Primary Industries and the State Government of Victoria to report the outcome of GPRS communications technology, performance and functionality tests conducted during July and August 2007.

### **Confidentiality**

The contents of this document are confidential and at all times remain 'commercial-in-confidence'.

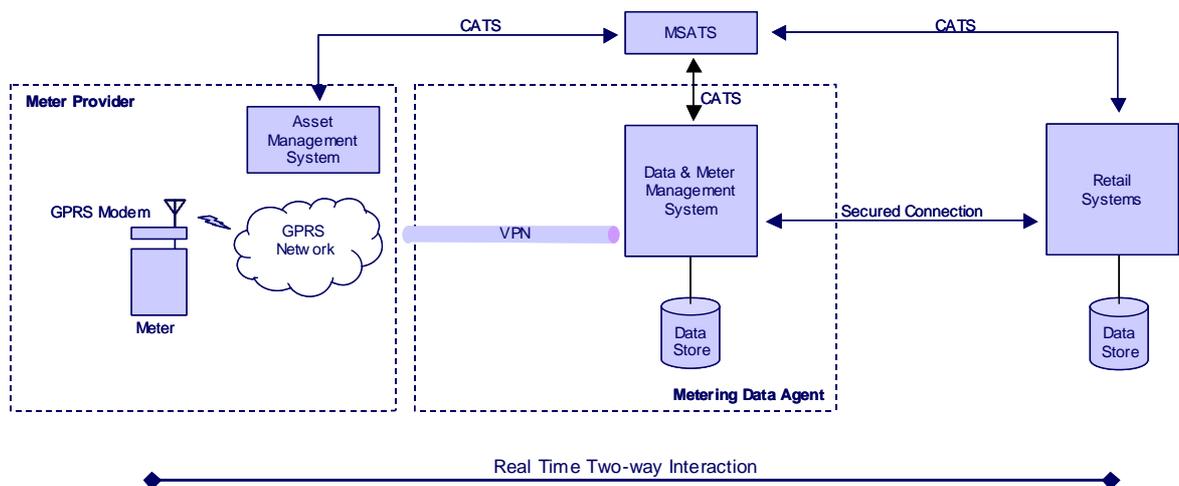
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## Plug-&-Play

The service providers and vendors participating in this trial have conformed to a *plug-and-play* architecture that encourages competition among:

1. Meter Manufacturers to supply single and multi-phase smart meters with a range of functional configurations, including multiple datastreams, multiple circuits and remote disconnect/reconnect facilities.
2. Metering Providers financially responsible for the deployment of smart meters that meet the Minimum Statewide Functional Specification and the ongoing asset management of those meters.
3. Communications Carriers to provide access to wireless telecommunications networks, such as GPRS, and virtual private networks.
4. Metering Data Agents with the necessary translation applications to communicate with meters, translate data packets as they are received and otherwise interact with each meter's value added features.

As such, a fully integrated, turn-key solution is not required to support the deployment of advanced metering.



## GPRS Two-way Communications Architecture

### Two-Way Communications

GPRS (or General Packet Radio Service) is a wireless communications technology for Global System for Mobile (GSM) networks that adds packet-switching protocols. The transfer of data over GPRS is typically charged at a megabyte rate, while data communication via traditional circuit switching is billed per

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minute of connection time, independent of whether the user has actually transferred data or has been in an idle state.

GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), Internet communication services such as email and World Wide Web access, and machine-to-machine (M2M) applications – such as smart metering.

GPRS networks are configured to allow multiple concurrent connections at anytime and, with a very low data transfer rate per meter (approximately 1-2kb per day) and the ability to stagger data transfer as required, can accommodate millions of smart meters (and indeed other M2M devices) rolled out over the next five years.

A secured wireless virtual private network is used to maintain connectivity with the meters over the GPRS network and a VPN over the public Internet facilitates two-way communications for the delivery of metering data and other interactions with each meter. This allows each smart meter to remain connected, much like a server remains connected to the Internet. Charging occurs only in relation to the amount of traffic between each meter and the relevant Metering Data Agent.

Each Metering Data Agent is identified by a unique code – such as an IP Address assigned by a telecommunications provider – but it can be any code. This code is set in the meter as the destination point for any communications emitting from the meter.

This means that the meter initiates contact rather than the back-end systems, as with a typical GSM dial-up solution, allowing inbound data packets to be rapidly processed in any collection frequency.

Smart meters are programmed to ‘push’ metering data to the relevant Metering Data Agent’s back-end data collection system at a pre-determined time every twenty-four hours.

It is a relatively simple matter of remotely resetting the destination code to redirect control to another Metering Data Agent as required.

Static IP addressing at each meter allows the authorised Metering Data Agent to communicate with specific meters at anytime to request special reads, disconnect the meter or operate other value-added features.

Metering Data Agents may allow Retailers and other market participants to initiate transactions directly through secured back-end system interfaces.

## **Interoperability**

Smart meters are controlled by proprietary firmware (software burned into a microprocessor contained in the meter) developed for each model by the metering manufacturer.

Firmware includes protocols to interface with the meter to obtain data and control other meter functions. Although there are Australian protocol standards for extracting data, most protocols contain proprietary command features.

Metering Data Agents are required to develop translation applications for each of the proprietary communication and command protocols supplied by each the meter manufacturers for their make and models.

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## Security

Traffic containing meter data that travels through the GPRS network and public Internet is encrypted using IPsec based VPN tunnels.

IPsec provides the following security protections for IP traffic:

- encryption so that it cannot be read by parties other than those for whom it is intended;
- integrity validation to ensure traffic has not been modified along its path;
- peer authentication ensuring that traffic is from a trusted party; and
- anti-replay to protect against replay of the secure session.

Interval meter protocols provide security login (such as username and password) to ensure that only authorised Metering Data Agents access the meter. Before the meter will respond to any data requests, or any other operation, it must be preceded by a login request, unique to a Metering Data Agent. All login request packets send the password in an encrypted form, which cannot be reverse engineered by capturing meter traffic.

The relevant telecommunications carrier configures the SIM cards used in the GPRS modems to access only a single, authorised Access Point Name (APN), which provides routing information for SGSN (Serving GPRS Support Nodes) and GGSN (Gateway GPRS Support Nodes).

The APN consists of two parts:

- the Network ID, which identifies the external GPRS service being used; and
- the Operator ID which specifies routing information.

Unauthorised access to an APN is therefore not possible as the telecommunications carrier will only provide such SIM cards at the specific request of the APN holder. Note that APN access can also be removed upon request for any SIM card that may be lost or stolen.

## Key Features

The key AMI features and functional capabilities allowed by this architecture include:

- two-way communications;
- time-synchronisation;
- routine reads (daily);
- special reads (on demand);
- active & reactive energy;
- import/export;
- meter alarms;
- settlements ready data delivery to NEMMCO;
- NEM12 data delivery to:
  - Retailers; and
  - Distributors;

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- customer transfers;
  - remote disconnect/reconnect;
  - controlled load management;
  - remote re-programming.

Deployment of GPRS capable smart meters is considered suitable for both urban and rural areas.

### **Extensibility**

Such a *plug-and-play* architecture affords a high degree of extensibility across all major components. Notably, the activities of competitors focussed on one or another part of the architecture need not be hindered from developing new capabilities, as the other existing components need not necessarily be changed to accommodate subsequent improvements.

Moreover, this level of extensibility encourages the entry of new and more efficient service providers to the market.

### Centurion Metering Technologies Pty Ltd

Centurion is accredited by the National Electricity Market Management Company (NEMMCO) as a Metering Data Agent, specialising in the use of remote polling technologies to collect and manage metering data, and provide a range of value added services.



Recognising that the quality of any advanced metering solution is dependent on back-end systems capable of effectively communicating with an ever expanding network of smart meters, Centurion set-out in early 2003 to develop a robust and flexible, data collection, processing and storage solution that can be scaled to handle multiple data streams from hundreds-of-thousands through to millions of interval meters.

Centurion's system utilises the proprietary communication and command protocols made available by metering manufacturers for specific models – allowing Centurion to read any make and model of meter that may be deployed by Metering Providers.

Centurion envisages an application service provider model rather than systems being fragmented between market participants, taking the view that users of advanced metering functions – Retailers and Distributors – are best served by dealing with a service provider, expert in advanced metering and two-way communications, rather than directly with the technology itself.

With its fast and reliable ability to issue commands to each meter, and receive prompt confirmation that each command has been accepted and initiated, the range of value-added functions available is limited only by what can be engineered at the meter itself.

Furthermore, the ability to provide secure connections between Centurion's systems and external systems will allow Retailers and Distributors to interact with each meter for specific functions – such as load control, special reads and remote disconnects – by-passing the need to initiate 'service requests' using industry B2B transaction processes.

All two-way meter connectivity during this trial has been achieved using Centurion's back-end system, which incorporates network management, data processing, validation, exception management and data delivery capabilities.

Separating the communications and data collection processes from the Metering Data Agent's back-office data processing and validation functions is unwarranted, serving only to add unnecessary complexity and delays to data management activities.

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## Metropolis Metering Assets Pty Ltd

Metropolis is an accredited Metering Provider (Category B), responsible for the installation, testing, repair and ongoing maintenance of metering assets. The company competes directly with electricity Distribution businesses for the right to own and operate smart meters in the National Electricity Market.



Metropolis has been responsible for the selection and deployment of the necessary meters and communications equipment in the field – noting that Metropolis has taken full financial ownership for the AMI assets – including cost of the metering and GPRS hardware – in line with a competitive deployment model.

Metropolis has the capability to deploy metering assets anywhere within the state of Victoria and has developed installation and commissioning processes specifically catered to advanced metering.

Metropolis takes full financial ownership of the smart meters it deploys and, to ensure the subsequent risk of meter churn is mitigated, requires that the metering manufacturers from which it purchases meters provide their proprietary communications and command protocols to accredited Metering Data Agents.

## Performance

### Origin Energy

As a Financially Responsible Market Participant, Origin Energy's data integrity group constantly monitors meter data availability and quality on a daily basis. The system and process works by exception and reports on missing data and quality issues, primarily substitutions.

Notwithstanding a relatively small sample size, data quality, reliability and timeliness is rated as extremely high, with no issues or concerns reported.

Origin Energy in its role as a National Electricity Rules Responsible Person, and in consideration of its long term market experience as a Responsible Person working with a full range of vendors within the market, over a large number of sites, can state, notwithstanding a relatively small sample size, the performance of Metropolis in all areas has been to a high standard with no major issues or concerns raised.

Any minor issues that have occurred have been addressed promptly and effectively by the vendor.

### Red Energy

Red Energy's meter data management systems and processes have been designed to achieve timely and accurate customer billing and early identification of missing meter reads or data quality problems. Red Energy is very satisfied with the timeliness and quality of data received from Centurion since the first trial meters were installed for Red in February 2007 in its capacity as Responsible Person.

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Centurion and Metropolis have also provided excellent customer service and support to Red Energy throughout the trial.

Victoria Electricity

Victoria Electricity has existing relationships with many existing vendors and has been very active in the retail market.

From an operational perspective, Victoria Electricity has been more than satisfied with the technology and service performance delivered to date. Victoria Electricity has been satisfied with the data quality and timeliness of the data.

Additionally, albeit a relatively small trial size, Metropolis' service, reliability, responsiveness and implementation has been smooth.

To date no hardware problems or data integrity issues have been identified or reported.

### EDMI

Metering hardware and components has been supplied by EDM I – which designs and manufactures innovative and technologically advanced electronic metering equipment for remote meter reading. The company has an extensive range of products available for use across the National Electricity Market on residential, small business, commercial, corporate and industrial sites.



All EDM I meters are fully compliant with IEC standards as well as specific national standards around the world.

EDMI has designed its meters for GPRS – with GSM dial-up available as a fall-back when required. Each meter includes an internal modem power supply, saving costs associated with the additional hardware and installation of a separate power supply pack and general purpose outlet. The meters are also programmed to display signal strength and confirm back-end system connectivity on the meter LCD, to assist in the efficient commissioning of the meter.

EDMI has included an inbuilt UDP/IP stack in each meter, allowing the use of a standard modem rather than the more expensive TCP/IP enabled modem and ensuring that communications costs are minimised through the use of Universal Data Protocol (UDP) .

A complex state machine has been developed in each meter to monitor and control the GPRS modem function. In the event that a modem does not respond – or ‘hangs’ – the EDM I meter can cycle the power to the modem to reinitialise the network connection.

The proprietary communications and command protocols needed to interact with EDM I meters are made freely available by EDM I to all accredited Metering Data Agents.

### Meters

Three EDM I meters have been deployed during this trial.



The Mk10 is a cost-effective solution for the residential and small to medium enterprise Polyphase Class 1 electronic interval meter market.

In addition to being installed at a number of three-phase and two phase sites, the meter has also proved versatile for single-phase configurations with multiple circuits. Notably, the Mk10 has been installed at sites with hot water load control, utilising the existing mechanical time switch, and in one case also measures slab heating on separate circuits to the main power supply.

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The Mk7C is a compact single element, single-phase meter designed specifically for the residential interval meter market.

Like the Mk10, the Mk7C is part of the EDM I Atlas Series and has inherited all of the firmware functionality found in the Mk10 Three Phase meter.

All Mk7C meters deployed for this trial have relays for remote disconnect/reconnect and the firmware in several meters has been configured to measure bi-directional flow (import/export) prevalent at sites with solar PV panels.



The Mk7A is a fully featured two element, single-phase meter designed for residential sites with hot water load control.

The meter is designed to replace existing configurations consisting of two electromechanical meters with separate time switch and electronic time-of-use and interval meters with internal load controls.

The meter can also be used to measure the output of solar PV panels separately, but none were deployed during this trial with such a configuration.

## Modems

The Intercel SAM2 is a Class 2 GPRS modem based around the Wavecom Wismo 2403A module. EDM I has extensive experience with this device, which fits directly under the terminal cover of EDM I Mk10, Mk7C and Mk7A meters.

This modem has been used exclusively during this trial, which is provided with an externally mounted antenna suitable for most locations.



## Locations

It was determined to select trial sites across as broad an area as possible to demonstrate that a GPRS deployment need not be constrained by geographic density considerations.

It is noted that Distributor Line Carrier (DLC) and other technologies that rely on an intermediary communications layer – such as a network of data concentrators – require that the communications be utilised by all smart meters to justify the capital outlay.

The fewer sites that subscribe to the usage of the intermediary communications layer the higher the apportioned capital cost per meter that does use the network – and the higher the charges per meter to recover that cost.

Effectively, without – close to – 100% site utilisation, DLC and similar technologies are economically unviable.

As the capital outlay associated with GPRS technologies is confined to each site, the percentage of sites subject to the deployment in any given area is irrelevant.

This trial has also demonstrated that it is possible for competitive Metering Providers to effectively ‘pool’ work orders from across a number of Retailers. In any given area, meter replacements were completed on behalf of 3-to-4 different Retailers at the same time.

A full listing of trial sites is available at Appendix A.

## Meter Configurations

A broad geographic foot-print also ensured that a variety of meter configurations and site conditions were encountered.

Smart meters have been installed at sites with the following configurations:

- 69 x single phase, single element;
- 4 x single phase, single element with the solar PV panels;
- 15 x single phase, two element with hot water load control;
- 1 x single phase, three element with hot water load control and slab heating;
- 2 x two phase; and
- 9 x three phase.

**Typical single phase hot water load control configuration – two meters with a separate time switch.  
(Replaced with a single smart meter).**



### Test Case One: Daily Meter Read & Validation

This test demonstrates the effectiveness, reliability and performance of:

- the deployed network of remotely read interval meters in measuring, recording and transmitting metering data;
- the GPRS communications network, for collecting metering data from remotely read interval meters; and
- Metering Data Agent back-office communications and data management systems for collecting and validating metering data from remotely read interval meters.

The network of 'live' smart meters was monitored for three consecutive weeks from Sunday, 15 July 2007 to Saturday, 4 August 2007 – covering three full settlement trading weeks.

Metering data collected during this period included:

- 48 x ½-hour intervals per datastream;
- measurements for active energy;
- measurements for reactive energy (where applicable);
- measurements for import and export (where applicable); and
- meter events and alarms.

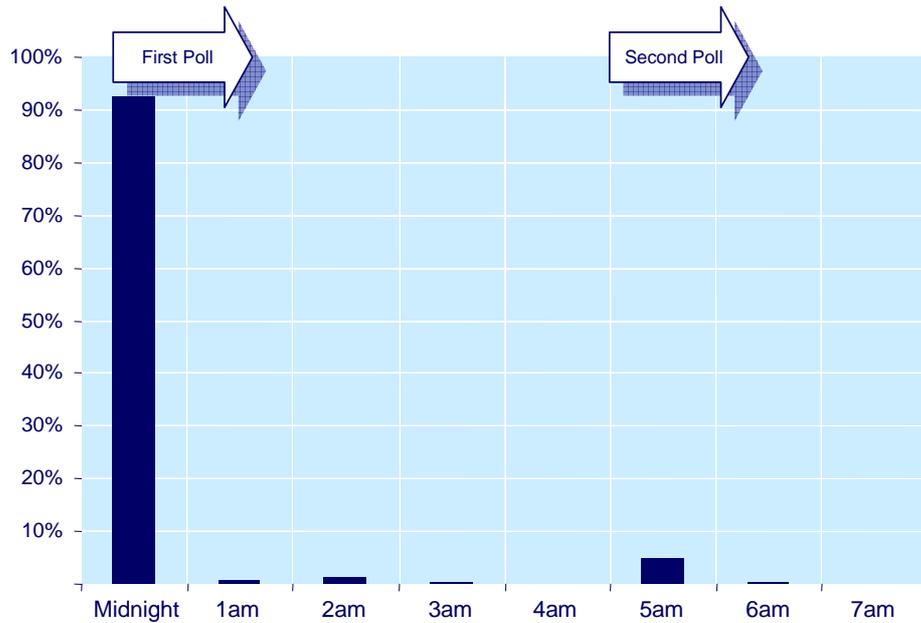
At the time monitoring commenced 92 of the planned 100 meters had been deployed. A further eight meters were installed on 25, 26 & 27 July 2007.

By the last week of testing 137 data streams were being collected consisting of 6,576 intervals each day.

Centurion's systems are programmed to automatically re-poll meters that have not delivered metering data by 5am, with the intention of collecting all metering data no later than 8am each morning – noting that each interval value is validated as it is received from the meter to allow Centurion to manage data validation exceptions from start of business each day (around 8.30am).

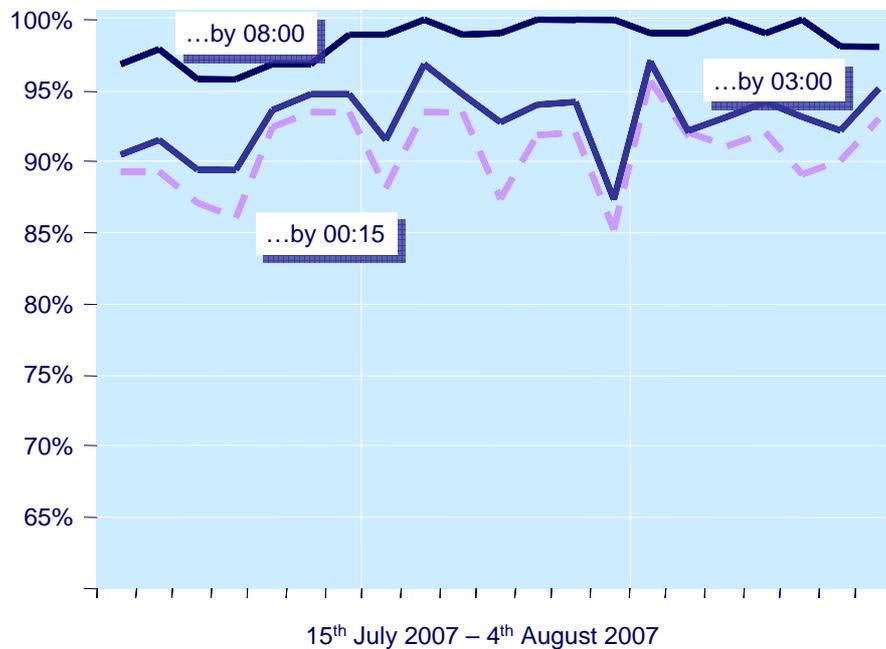
During the monitoring period approximately 92% of metering data was collected in the hour immediately after midnight and approximately 5% collected immediately after 5am.

While Centurion has the ability to check for undelivered data at anytime, and at multiple times, it was not deemed necessary or appropriate to reprogram the 5am check time for this trial as Centurion's systems are in full production.



**Daily Data Collection Times**

During the first week of monitoring, a modem configuration error prevented two meters (one at Aireys Inlet and another at Viewbank) from establishing connectivity over a number of days. This was because these two particular meters had been installed with external modem power supplies – not internal power supplies as with all other sites.



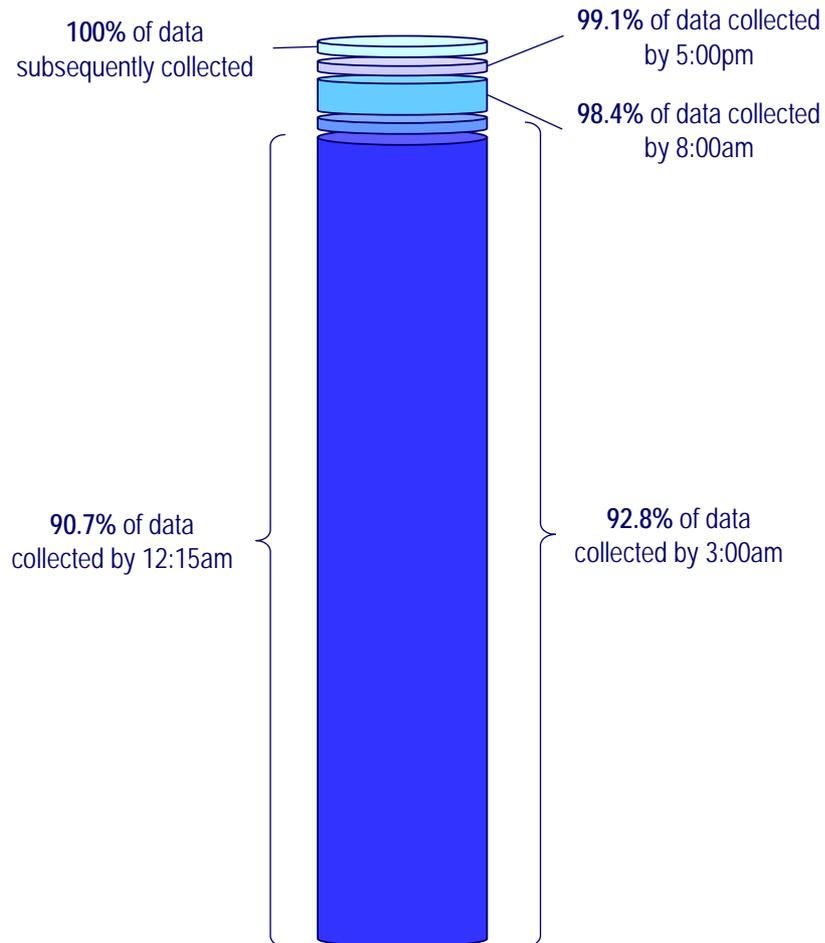
**Percentage of meters successfully polled each day**

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As such, between 95% and 97% of the meters were successfully polled by 8am the next day during week one to collect metering data recorded from midnight-to-midnight the previous day.

The modems on both meters were subsequently corrected in the field and all outstanding data recovered remotely.

Weeks two and three show a better result, consistently achieving success rates above 98% by 8am. 100% of meters were successfully polled by 8am on successive days.



Overall, 90.7% of meters were successfully polled by 12:15am, 92.8% of meters were successfully polled by 3am, and 98.4% of meters were successfully polled by 8am during the monitoring period.

Data from approximately 1% of meters was collected more than 24-hours after the measurement date, which, apart from the incorrect modem configuration on the two meters at set-up, appears to be due to the modem power cycle function on the EDMI meters, to reinitialise the network connection when it is lost, not working as effectively as intended. This will be investigated and rectified.

All measurements for active energy and reactive energy were validated to identify erroneous and anomalous data values, in accordance with NEMMCO approved validation and substitution rules, and 100% of all data collected from the meters was accepted for delivery to market participants (refer Test Case Two: Daily Data Delivery).

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## Test Case Two: Daily Data Delivery

This test establishes that metering data collected utilising GPRS communications is delivered within the accuracy standards and delivery timeframes set by NEMMCO in accordance with the National Electricity Rules.

Once metering data is validated (and substituted where appropriate), the data must be delivered to:

- the relevant Financially Responsible Market Participant:
  - Origin Energy;
  - Red Energy;
  - Victoria Electricity;
  - Australian Power & Gas;
  - Momentum; and
  - Powerdirect.
- the relevant Distributor:
  - Alinta;
  - Citipower;
  - Powercor;
  - SPAusnet; and
  - United Energy.
- the relevant Local Retailer (where applicable):
  - AGL;
  - Origin Energy; and
  - TRU Energy.
- NEMMCO.

Data is delivered using the NEM12 data delivery file format or NEMMCO aseXML data delivery format, within two business days of collection.

Data delivery relating to the network of 'live' smart meters was monitored for three consecutive weeks from Sunday, 15 July 2007 to Saturday, 4 August 2007 – covering three full settlement trading weeks.

During that time 100% of all data collected was delivered to market participants within two business days, with the exception that data for several sites was not delivered to Origin Energy in its capacity as Local Retailer during week one.

Centurion identified and rectified this situation by week two.

The meter configuration at one single phase site had to be remotely reset to account for additional datastreams – requiring that the data not initially measured (and therefore not available for collection) be substituted.

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### **Test Case Three: Weekly Data Delivery (full data set)**

This test establishes that metering data collected utilising GPRS communications is delivered within the accuracy standards and delivery timeframes set by the National Electricity Rules and NEMMCO.

A 100% complete data set (that is, containing no 'nulls' or missing data) must be delivered to NEMMCO by 5pm on the second business day after each trading week so that NEMMCO may calculate weekly settlements statements. This requires that both actual and substituted (temporary or final) values must be delivered to NEMMCO.

NEMMCO assesses the Metering Data Agent's performance based on the percentage of actual data values delivered as follows:

- Excellent = no less than 99.4% actual data;
- Satisfactory = no less than 97.9% actual data;
- Unsatisfactory = no less than 98.0% actual data; and
- Poor = anything less than 90.0% actual data.

Data delivery relating to the network of 'live' smart meters was monitored for three consecutive weeks from Sunday, 15 July 2007 to Saturday, 4 August 2007 – covering three full settlement trading weeks.

Data sets were delivered to NEMMCO by 5pm on the second business day after each trading week, with the following percentages of actual data:

- Week ending Saturday 21 July 2007 – 99.92% actual data;
- Week ending Saturday 28 July 2007 – 100% actual data; and
- Week ending Saturday 4 August 2007 – 100% actual data.

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## Test Case Four: Remote Re-program (1)

This test establishes that remotely read interval meters can be remotely reprogrammed to measure and record reactive energy in addition to active energy, avoiding the need (and expense) for field technicians to attend sites with reprogramming equipment (eg. laptops).

Four executions of this test case were attempted and successfully completed by Centurion as follows:

NMI	Action	Date
6102860204(1)	Add reactive datastream.	26 <sup>th</sup> July 2007
6407597601(0)	Add reactive datastream.	26 <sup>th</sup> July 2007
6305237864(3)	Add reactive datastream.	26 <sup>th</sup> July 2007
6001082159(5)	Add reactive datastream.	30 <sup>th</sup> July 2007

Note that the collection of the additional datastreams is reflected in the performance statistics recorded for test cases one, two and three.

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## Test Case Five: Remote Re-program (2)

This test establishes that smart meter time-switch settings, for secondary appliance circuits, can be remotely reprogrammed, avoiding the need (and expense) for field technicians to attend sites with reprogramming equipment (eg. laptops).

Four executions of this test case were attempted and successfully completed by Centurion as follows:

NMI	Action	Date
6203367578(9)	Time-switch on/off times reprogrammed from 23:00-07:00 to 21:00-23:00 and 02:30-06:30 on load circuit.	23rd July 2007
6203479337(3)	Time-switch on/off times reprogrammed from 23:00-07:00 to 21:00-23:00 and 02:30-06:30 on load circuit.	24th July 2007
6102860204(1)	Time-switch on/off times reprogrammed from 23:00-07:00 to 23:30-07:00 on load circuit.	26th July 2007
6001084671(8)	Time-switch on/off times reprogrammed from 23:00-07:00 to 23:30-07:00 on load circuit.	30th July 2007

## Test Case Six: Special Read

This test establishes that metering data, up to the most recent full interval measured and recorded by the meter, is available to Retailers upon request.

A web interface was provided by Centurion to allow participating Retailers to directly access metering data from each meter in the network of 'live' smart meters.

Special reads obtained in  
**20 seconds**



Origin Energy, Red Energy and Victoria Electricity each attempted and successfully completed six executions of this test case as follows:

NMI	Retailer	Date	Response
6102222156(6)	Origin Energy	3rd August 2007	14 seconds
6305254266(1)	Origin Energy	3rd August 2007	17 seconds
6203231328(2)	Origin Energy	3rd August 2007	13 seconds
6001094233(2)	Origin Energy	3rd August 2007	13 seconds
6001301303(5)	Origin Energy	3rd August 2007	14 seconds
6001112768(7)	Origin Energy	3rd August 2007	14 seconds
6102900751(5)	Red Energy	30th July 2007	27 seconds
6305148669(6)	Red Energy	30th July 2007	27 seconds
6102102221(5)	Red Energy	30th July 2007	24 seconds
6001031828(6)	Red Energy	30th July 2007	23 seconds
6001140087(9)	Red Energy	30th July 2007	23 seconds
6407603665(7)	Red Energy	7th August 2007	23 seconds
6102311823(3)	Victoria Elec.	31st July 2007	40 seconds

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<b>NMI</b>	<b>Retailer</b>	<b>Date</b>	<b>Response</b>
6001235526(0)	Victoria Elec.	31st July 2007	30 seconds
6407182327(0)	Victoria Elec.	31st July 2007	15 seconds
6407597601(0)	Victoria Elec.	31st July 2007	15 seconds
6305474534(5)	Victoria Elec.	31st July 2007	15 seconds
6305239872(4)	Victoria Elec.	31st July 2007	20 seconds

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## Test Case Seven: Remote Disconnect (General Supply)

This test establishes that a Retailer can remotely disconnect the electricity supply to a specified site in real time, as an alternative to manually removing service fuses.

A web interface was provided by Centurion to allow participating Retailers to initiate remote disconnections on the network of 'live' smart meters.

An observer was present at each site to confirm the disconnection and the response time.

Remote disconnections achieved in  
**5 seconds**



Origin Energy and Red Energy each attempted and successfully completed executions of this test case, during normal business hours, as follows:

NMI	Retailer	Date	Response
6305171424(6)	Origin Energy	6th August 2007	7 seconds
6305171424(6)	Origin Energy	6th August 2007	7 seconds
6305254266(1)	Origin Energy	7th August 2007	5 seconds
6001112768(7)	Origin Energy	7th August 2007	5 seconds
6001112768(7)	Origin Energy	7th August 2007	8 seconds
6102843163(0)	Red Energy	7th August 2007	3 seconds
6001031828(6)	Red Energy	8th August 2007	3 seconds
6001089787(4)	Red Energy	8th August 2007	3 seconds
6102102221(5)	Red Energy	8th August 2007	3 seconds

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## Test Case Eight: Remote Reconnect (General Supply)

This test establishes that a Retailer can remotely re-connect the electricity supply to a specified site in real time, where the site has previously been remotely disconnected.

A web interface was provided by Centurion to allow participating Retailers to initiate remote reconnections on the network of 'live' smart meters.

An observer was present at each site to confirm the reconnection and the response time.

Remote reconnections achieved in  
**6 seconds**



Origin Energy and Red Energy each attempted and successfully completed executions of this test case, during normal business hours, as follows:

NMI	Retailer	Date	Response
6305171424(6)	Origin Energy	6th August 2007	3 seconds
6305171424(6)	Origin Energy	6th August 2007	7 seconds
6305254266(1)	Origin Energy	7th August 2007	7 seconds
6001112768(7)	Origin Energy	7th August 2007	6 seconds
6001112768(7)	Origin Energy	7th August 2007	3 seconds
6102843163(0)	Red Energy	7th August 2007	5 seconds
6001031828(6)	Red Energy	8th August 2007	8 seconds
6001089787(4)	Red Energy	8th August 2007	10 seconds
6102102221(5)	Red Energy	8th August 2007	8 seconds

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## Test Case Nine: Remote Arming

This test establishes that a Retailer can remotely arm a meter in real time, where the site has previously been remotely disconnected and disarmed. This function does not immediately re-energise a site but allows a person to reconnect the power, by depressing a button on the meter, when it is safe to do so.

A web interface was provided by Centurion to allow participating Retailers to initiate remote reconnections on the network of 'live' smart meters.

An observer was present at each site to confirm the reconnection and the response time.

Meters remotely re-armed in  
**6 seconds**



Origin Energy and Red Energy each attempted and successfully completed executions of this test case, during normal business hours, as follows:

NMI	Retailer	Date	Response
6305171424(6)	Origin Energy	6th August 2007	6 seconds
6305254266(1)	Origin Energy	7th August 2007	10 seconds
6001112768(7)	Origin Energy	7th August 2007	8 seconds
6102843163(0)	Red Energy	7th August 2007	3 seconds
6001031828(6)	Red Energy	8th August 2007	3 seconds
6001089787(4)	Red Energy	8th August 2007	3 seconds
6102102221(5)	Red Energy	8th August 2007	5 seconds

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## Test Case Ten: Recovery From Power Failure

This test establishes that remotely read interval meters continue to operate effectively when a power failure has occurred.

A power failure was simulated at the following six sites by removing the service fuse for approximately 15 minutes+.

NMI	Date	Outage Time
6001123652(9)	3rd August 2007	10:26-10:47
6001031828(6)	3rd August 2007	10:25-10:46
6001031915(3)	3rd August 2007	10:18-10:41
6001031971(6)	3rd August 2007	10:11-10:37
6001032269(1)	3rd August 2007	10:03-10:32
6001042957(9)	3rd August 2007	10:59-11:18

Centurion subsequently verified that power on/off events were logged and correlated to the approximate times the service fuses had been removed. The meters continued to function as normal and metering data, including the relevant event logs, were subsequently collected.

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## Test Case Eleven: Load Control ('Load Shedding')

This test establishes that power can be remotely disconnected and reconnected simultaneously across a predetermined group of disparately located sites – demonstrating that Retailers, through a competitive rollout of AMI, can and will provide the means through which Distributors can initiate load control activities.

A web interface was provided by Centurion to allow participating Retailers to initiate remote disconnections and reconnections across multiple sites on the network of 'live' smart meters.

Customer permission was obtained to disconnect supply for approximately one hour and three load control groups were established as follows:

Load Control Group One – Origin Energy:

- 6305198685(2);
- 6001112768(7); and
- 6407629076(6).

Load Control Group Two – Red Energy:

- 6102843163(0);
- 6001031828(6); and
- 6001089787(4).

Load Control Group Two – Victoria Electricity

- 6001235526(0);
- 6407183347(7);
- 6001067277(3);
- 6001149988(7); and
- 6001082429(0).

Origin Energy, Red Energy and Victoria Electricity each attempted and successfully completed one execution of this test case, during normal business hours, as follows:

NMIs	Date	Outage Time
Group One	7th August 2007	10:50-11:35
Group Two	7th August 2007	10:15-11:15
Group Three	7th August 2007	10:00-11:10

All meters in each of the load control groups were successfully disconnected with a single command to switch off those sites initiated by the respective Retailers.

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A firmware configuration error in the meters at NMIs 6001235526(0) and 6001089787(4) disabled the ability to reconnect these sites with the other meters in the load control group. Centurion Metering Technologies remotely rectified this and the meters were reconnected at 11:20 and 11:25 respectively. All the meters were otherwise successfully reconnected with a single command to switch on those sites initiated by the respective Retailers.

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## Test Case Twelve: Time Synchronisation

This test establishes that the time clocks within remotely read interval meters will be maintained in accordance with Table S7.2.3.1 of the National Electricity Rules – Overall Accuracy Requirements of Metering Installation Components – requiring that Type 3 and Type 4 metering installations contain respective clock errors of no more than +/-10 seconds and +/- 20 seconds from Australian Eastern Standard Time.

Each packet generated by a smart meter is dated and time stamped. As each data packet is received, Centurions systems check the time of the packet against the server time – which is it self synchronised to Australian Eastern Standard Time.

In most operating circumstances GPRS networks can be relied upon to deliver data packets in well under a second.

In the event that the time stamped on the data packet differs from Centurion's server time by greater than +/-5 seconds, a Time Set Command is automatically issued to the meter to reset its clock. This is logged as an event in the meter. In normal circumstances a Time Set Command will reset the meter to within a few seconds of Australian Eastern Standard Time.

To execute this test Centurion remotely reset the time in the following meters outside of the time synchronisation tolerance of +/- 5 seconds, but within the +/- 20 seconds limit set under the National Electricity Rules:

NMI	Date	Change Time	Correction Time
6203449809(9)	31st July 2007	15:27	00:06
6407336651(0)	31st July 2007	15:33	00:06
6203710573(6)	31st July 2007	15:37	00:06
6001140087(9)	31st July 2007	15:41	00:06

In each case the time was reset to within the +/- 5 seconds time synchronisation tolerance when the meter next contacted Centurion's systems to deliver its metering data.

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### **Test Case Thirteen: Customer Transfer (New FRMP)**

This test aims to establish that remotely read interval meters allow the prompt transfer of customers, without the need for or risk of a meter change, immediately an MSATS transfer request moves to 'pending' status.

During the course of July 2007, six sites transferred between Retailers.

One transfer occurred between Red Energy and Victoria Electricity at the request of the customer. Five other sites transferred to a Retailer with which neither Metropolis nor Centurion had a previous commercial relationship as metering service providers. In all cases the transfers were immediately completed – Centurion ceasing to deliver metering data to the 'old' FRMP and commencing to deliver metering data to the 'new' FRMP.

None of the meters have been 'churned' as a result of the transfers.

## Trial Sites

#	Location	NMI	Meter Configuration
1	Hopkins Street Aireys Inlet 3231	6203367578(9)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
2	Princes Street Ararat 3377	6203710573(6)	Single Phase with Main Supply Remote Disconnect
3	Princes Street Ararat 3377	6203710575(2)	Single Phase with Main Supply Remote Disconnect
4	Baker Parade Ashburton 3147	6407297194(7)	Three-phase
5	Brougham Street Ballarat 3350	6203231328(2)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
6	Sturt Street Ballarat 3350	6203703595(8)	Single Phase with Main Supply Remote Disconnect
7	Webb Street Brighton 3186	6407275028(3)	Single Phase with Main Supply Remote Disconnect
8	Albion Street Brunswick 3056	6102222156(6)	Single Phase with Main Supply Remote Disconnect
9	Ann Street Brunswick 3056	6102563004(6)	Single Phase with Main Supply Remote Disconnect (and Solar Energy)
10	Katawa Grove Brunswick 3056	6102900751(5)	Single Phase with Main Supply Remote Disconnect
11	Lyle Street Brunswick 3056	6102741275(5)	Single Phase with Main Supply Remote Disconnect
12	Trafford Street Brunswick 3056	6102213044(6)	Single Phase with Main Supply Remote Disconnect
13	Victoria Street Brunswick 3056	6102520581(3)	Three-phase
14	Cumming Street Brunswick West 3055	6102101099(7)	Single Phase with Main Supply Remote Disconnect
15	Pearson Street Brunswick West 3055	6102311823(3)	Single Phase with Main Supply Remote Disconnect
16	Wattle Valley Road Brunswick West 3055	6102706220(6)	Single Phase with Main Supply Remote Disconnect

#	Location	NMI	Meter Configuration
17	Lea Crescent Bundoora 3083	6305231195(2)	Single Phase with Main Supply Remote Disconnect
18	Colles Road Castlemaine 3450	6203449809(9)	Single Phase with Main Supply Remote Disconnect
19	Lockhart Street Caulfield 3162	6407336651(0)	Single Phase with Main Supply Remote Disconnect
20	Lumeah Road Caulfield North 3161	6407328121(5)	Three Phase (Direct Connect)
21	Aitken Street Clifton Hill 3068	6102076656(2)	Single Phase with Main Supply Remote Disconnect (and Solar Energy)
22	Berry Street Coburg 3058	6001030857(6)	Single Phase with Main Supply Remote Disconnect
23	Deakin Street Coburg 3058	6001030957(4)	Single Phase with Main Supply Remote Disconnect
24	Devon Avenue Coburg 3058	6001235526(0)	Single Phase with Main Supply Remote Disconnect
25	Bowman Road Cowes 3922	6305468775(3)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
26	Wensley Street Diamond Creek 3089	6305254266(1)	Single Phase with Main Supply Remote Disconnect
27	Braeside Drive Doncaster 3108	6407182327(0)	Single Phase with Main Supply Remote Disconnect
28	Marshall Avenue Doncaster 3108	6407183347(7)	Single Phase with Main Supply Remote Disconnect
29	Westfield Drive Doncaster 3108	6407691640(3)	Single Phase with Main Supply Remote Disconnect
30	Boundary Road Dromana 3936	6407599958(8)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
31	Murradoc Road Drysdale 3222	6203000634(6)	Three-phase
32	Taunton Street East Doncaster 3109	6407187194(1)	Three-phase
33	George Street East Melbourne 3000	6102843163(0)	Single Phase with Main Supply Remote Disconnect
34	Milborne Crescent Eltham 3095	6305205773(6)	Three-phase

#	Location	NMI	Meter Configuration
35	Woongarra Court Eltham 3095	6305577924(3)	Single Phase with Main Supply Remote Disconnect
36	Byron Street Elwood 3184	6407283918(4)	Single Phase with Main Supply Remote Disconnect
37	Willowbank Road Fitzroy North 3068	6102860204(1)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
38	Bass Street Flinders 3929	6407597601(0)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
39	Stanley Road Grantville 3984	6305474534(5)	Two-phase
40	Stanley Road Grantville 3984	6305480418(4)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
41	Sellars Street Greensborough 3088	6305237864(3)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
42	St Helena Road Greensborough 3088	6305239872(4)	Single Phase with Main Supply Remote Disconnect
43	Woodlands Road Heathmont 3135	6305313539(1)	Single Phase with Main Supply Remote Disconnect (and Solar Energy)
44	Magnolia Road Ivanhoe 3079	6001067277(3)	Single Phase with Main Supply Remote Disconnect
45	Jeeves Avenue Kalorama 3766	6305148669(6)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
46	Mcperson Street Keilor East 3033	6001159163(6)	Single Phase with Main Supply Remote Disconnect
47	Bangalore Street Kensington 3031	6001261575(6)	Single Phase with Main Supply Remote Disconnect
48	King Street Melbourne 3000	6102042567(1)	Three-phase
49	Azalea Avenue Mill Park 3082	6305198685(2)	Single Phase with Main Supply Remote Disconnect
50	Evans Street Moonee Ponds 3039	6001140088(7)	Single Phase with Main Supply Remote Disconnect
51	Evans Street Moonee Ponds 3039	6001140087(9)	Single Phase with Main Supply Remote Disconnect

#	Location	NMI	Meter Configuration
52	Centre Road Morewell 3840	6305008612(8)	Three-phase
53	Sobeys Road Napoleons 3352	6203672324(6)	Single Phase with Hot Water Load Control (Mechanical Time Switch) and Slab Heating Element
54	Heatherlea Crescent Narre Warren 3805	6305171424(6)	Single Phase with Main Supply Remote Disconnect
55	Auburn Avenue Northcote 3070	6102813303(9)	Single Phase with Main Supply Remote Disconnect
56	George Street Northcote 3070	6102923262(1)	Single Phase with Main Supply Remote Disconnect
57	Gladstone Avenue Northcote 3070	6102400045(8)	Single Phase with Main Supply Remote Disconnect
58	Johnson Street Northcote 3070	6102656204(8)	Single Phase with Main Supply Remote Disconnect
59	McLachlan Street Northcote 3070	6102463312(2)	Single Phase with Main Supply Remote Disconnect
60	Sumner Avenue Northcote 3070	6102530584(5)	Single Phase with Main Supply Remote Disconnect
61	Walker Street Northcote 3070	6102430572(1)	Single Phase with Main Supply Remote Disconnect
62	Barak Street Parkville 3052	6102031229(1)	Two-phase
63	Fitzgibbon Street Parkville 3052	6102094746(8)	Single Phase with Main Supply Remote Disconnect
64	Fitzgibbon Street Parkville 3052	6102649149(5)	Single Phase with Main Supply Remote Disconnect
65	Gatehouse Street Parkville 3052	6102545814(8)	Single Phase with Main Supply Remote Disconnect
66	Cumberland Road Pascoe Vale South 3044	6001039788(3)	Single Phase with Main Supply Remote Disconnect
67	Cumberland Road Pascoe Vale South 3044	6001042957(9)	Single Phase with Main Supply Remote Disconnect
68	Grandview Avenue Pascoe Vale South 3044	6001031915(3)	Single Phase with Main Supply Remote Disconnect

#	Location	NMI	Meter Configuration
69	Somali Street Pascoe Vale South 3044	6001032269(1)	Single Phase with Main Supply Remote Disconnect
70	Springhall Parade Pascoe Vale South 3044	6001031828(6)	Single Phase with Main Supply Remote Disconnect
71	Springhall Parade Pascoe Vale South 3044	6001123652(9)	Single Phase with Main Supply Remote Disconnect
72	Waverley Parade Pascoe Vale South 3044	6001031971(6)	Single Phase with Main Supply Remote Disconnect
73	Wharf Road Port Melbourne 3207	6102567513(1)	Three-phase
74	Spring Street Prahran 3181	6102102221(5)	Single Phase with Main Supply Remote Disconnect
75	Belmont Street Preston 3072	6001093945(3)	Single Phase with Main Supply Remote Disconnect
76	Emerald Street Preston 3072	6001112768(7)	Single Phase with Main Supply Remote Disconnect
77	Stafford Street Preston 3072	6001094233(2)	Single Phase with Main Supply Remote Disconnect
78	Walton Avenue Preston 3072	6001258893(5)	Single Phase with Main Supply Remote Disconnect
79	Youngman Street Preston 3072	6001102426(5)	Single Phase with Main Supply Remote Disconnect
80	Etnam Street Preston West 3072	6001095609(4)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
81	Buckingham Street Richmond 3121	6102999190(7)	Single Phase with Main Supply Remote Disconnect
82	Main Road Riddells Creek 3431	6203479337(3)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
83	June Square Ringwood 3134	6305516888(6)	Single Phase with Main Supply Remote Disconnect
84	Mines Road Ringwood 3135	6305308873(0)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
85	Lower Plenty Road Rosanna 3084	6001089787(4)	Single Phase with Main Supply Remote Disconnect

#	Location	NMI	Meter Configuration
86	Mountain View Parade Rosanna 3184	6001084151(2)	Single Phase with Main Supply Remote Disconnect
87	Owarra Street Rye 3941	6407604647(3)	Single Phase with Main Supply Remote Disconnect
88	Rochester Road Somerville 3912	6407629076(6)	Single Phase with Main Supply Remote Disconnect
89	Martin Street South Melbourne 3205	6102262766(2)	Single Phase with Main Supply Remote Disconnect
90	Paradise Drive St Andrews Beach 3941	6407603665(7)	Single Phase with Main Supply Remote Disconnect
91	Higgs Circuit Sunbury 3429	6001292793(4)	Single Phase with Main Supply Remote Disconnect
92	Seagull Place Sunbury 3429	6001301303(5)	Single Phase with Main Supply Remote Disconnect (and Solar Energy)
93	Oliver Road Templestowe 3106	6407180650(1)	Three-phase
94	Diane Crescent Viewbank 3084	6001082429(0)	Single Phase with Main Supply Remote Disconnect
95	Lyon Road Viewbank 3084	6001082132(2)	Single Phase with Main Supply Remote Disconnect
96	Mark Street Viewbank 3084	6001084671(8)	Single Phase with Hot Water Load Control and Main Supply Remote Disconnect
97	Warren Road Viewbank 3084	6001082159(5)	Single Phase with Main Supply Remote Disconnect
98	Wattle Flat Road Wattle Flat 3352	6203211723(0)	Single Phase with Main Supply Remote Disconnect
99	Wattle Flat Road Wattle Flat 3352	6203211724(8)	Single Phase with Hot Water Load Control (Mechanical Time Switch)
100	Electra Street Williamstown 3016	6001116010(5)	Single Phase with Main Supply Remote Disconnect

## Detailed Test Executions

The following pages contain detailed execution sheets for each performance monitoring and functional test case undertaken.