Communication cost allocation review

Operational Technology Solutions

Final Published

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1. Executive Summary

This report addresses the AER conclusion that it is sufficient to collect power quality data from 1% of meters to support the delivery of network operations. While a limited sampling approach is valid for simple voltage and power quality management functions (such as the SAPN low voltage monitoring program referred to in the AER Response [Ref: 1]), narrowing the frequency or proportion of AMI data collected by CitiPower, Powercor and United Energy for the purposes of network operations would adversely impact customer outcomes in terms of safety, reliability and customer service experience.

As an example, restricting the volume of Standard control services (SCS) traffic to 1% as set out in the AER Response [Ref: 2] is predicted to degrade Loss of Neutral (LoN) detection capabilities. Neutral fault integrity hazards can emerge at any time anywhere in the distribution territory with no warning. Following the emergence of a hazard a race condition occurs between the distribution business' detection/treatment process and a customer shock incident. The total time taken between the emergence of a hazardous fault and its treatment has a direct bearing on the incidence of customer shocks. **Minutes matter**. The design target for the business processes to detect and treat faults is **under two hours**. However, in most instances, the technical support teams react in minutes.

There have been incidents where the LoN fault was detected and the dispatch crew was prioritised to resolve the issue safely and expediently, however the customer had unfortunately received and shock before the maintenance crew arrived to fix the situation. In these cases, the ability to **automatically** turn off the power using data-driven workflows to proactively protect the customer from shock is a key benefit of having low-latency (near-real-time) access to the data from the network

The impact on customer outcomes from a degradation in loss of neutral detection capabilities associated with sampling only 1% of AMI data is stark with the average annual number of customer shock incidents predicted to increase from 20 to 70 at United Energy and from 40 to 130+ at CitiPower and Powercor. The rationale for this impact on outcomes is set out in Section 0. Similarly, sampling only 50% of AMI data would increase customer shock incidents by more than double, from 20 to 45 in United Energy and 40 to 85 in CitiPower and Powercor.

Furthermore, there have been 14 other use cases for network management functions delivered through AMI data that have been identified and many of these would be significantly degraded by sampling only 1% data with material reliability and safety consequences for customers. The sampling effect degrades the efficiency or effectiveness of analytics functions dependent on whole-of-network data. The other use cases are listed in section 5 of this report, however the Loss of Neutral function best illustrates the relationship between the reach and speed of power quality data collection and the consequences on customer outcomes.

United Energy, CitiPower and Powercor have all made significant strides in the use of metering data to improve the safe and efficient operation of the electrical network. The companies have invested heavily in the development of network analytics platforms and use cases that provide material benefits to consumers (over and above the simplistic use voltage use case noted by the AER). These use cases require data collection from all meters at higher frequencies that stated by the AER. If the number of meters or the frequency of polling were decreased there would be material safety, reliability and other detriments that would need to be considered.

This report recommends that the AER conclusion with respect to the sufficiency of 1% sampling of power quality data be reviewed in light of its effect on customer service outcomes stemming from functions including Loss of Neutral detection and other use cases outlined in this document.

2. Introduction

2.1. Instructions

Operational Technology Solutions (OTS) has been engaged by CitiPower / Powercor / United Energy (The Business) to provide an independent review of the use of AMI data for network management purposes and compile all activities that are undertaken with this data to assess:

- which network management activities require AMI data to provide operational and customer benefit
- The frequency and population size required to deliver these benefits

This report is produced based on more than a decade of experience with analytics and metering communications technologies deployed both nationally and internationally. Its purpose is to provide a general overview of the various use cases where AMI data is used to support the improvement of network operations and broader customer service improvements and examine the impacts of reducing the sampling of AMI data.

2.2. Background

In the Business' Regulatory Proposal 2021 – 2026 submitted to AER in January 2020, page 124 (paragraph 9.2.2) states:

> **Reclassification of operating expenditure related to the smart meter communications network**
> Our use of data analytics with smart meter data has now become part of our business-as-usual network optimisation. Our customers have told us they want us to keep finding more innovative ways for managing the network, and they will continue to benefit through lower costs from managing our network in this manner.
>
> For the 2021–2026 regulatory period, we have allocated 88% of the operating expenditure for maintaining our communications network from metering to standard control services. This amount represents the percentage of data transmitted through the smart meter communications network for network management purposes, the benefits of which are shared by all our customers.

Again, page 158, paragraph 11.2.3 of the same document states:

> The communications network transmits smart meter data at various intervals, depending on the use of that data. Currently we collect data at the following intervals:
>
> - usage data every 30-minutes
> - power quality data every 15 minutes
> - additional power quality data from various sites for advanced data analytics every 5 minutes.
>
> In 2018, power quality data accounted for 88% of all data collected and transmitted through the smart meter communications network. We expect this share to remain relatively constant by 2025/26. Given the smart meter communications network mainly transmits data used for network management and optimisation, the benefits of the communications network investment are largely shared by all our customers. As we continue to develop our smart meter data analytics to develop innovative ways to optimise the network and defer network augmentation, all our customers will continue to benefit from the smart meter communications network, including those with contestable meters.

For the 2021–2026 regulatory period, therefore, we have allocated future capital investment for communications device replacements, and operating expenditure related to maintaining the communications network, as follows:

- 88% to standard control services
- 12% to metering services.

Our forecast of the total capital volumes for communications devices is based on historical fault rates, and new growth based on customer numbers, which are outlined in the communications model.

AER's response, in paragraph 16.2.4.1 (page 38) states:

> DELWP and ECA have noted their support for additional network benefits being realised from AMI meters.84 The AER's Consumer Challenge Panel, sub-panel 17 (CCP17) was supportive of the trend that metering expenses be reallocated to standard control in instances where the functions support the improvement of network operations and broader customer service improvements.

On page 39, AER's response states:

> We consider the Business' proposal to use meter data volumes can be an appropriate causal driver to allocate costs. However, we disagree with the calculation of this driver. Namely, we consider the Business' proposed SCS meter data requirements are too high.
>
> We accept that, in areas where there is a high penetration of distributed energy resources (DER) exporting into the network that are causing (or have the potential to cause) high and low voltage problems, networks may want to capture power quality data from a small number of sites per low voltage feeder. However, we consider that this would only represent a very small proportion of sites in those parts of the network. For other parts of the network we expect the proportion of sites that it would be useful to capture power quality data from is even lower.
>
> More specifically, we consider it sufficient to collect power quality data from approximately one per cent of AMI meters. In arriving at the one per cent figure we have been guided by the knowledge and experience of our technical experts. For example, we have recently accepted SA Power Networks' proposed low voltage monitoring to address PV related power quality issues. This proposal involved implementing limited monitoring in targeted locations to sample the LV network, primarily through procurement of 'data as a service' from smart meter providers and other third parties.89 We have determined that monitoring approximately one per cent of connection points should be sufficient to deliver the outcomes suggested by the Business.

This report seeks to demonstrate the use of AMI data to support the safe and efficient operation of the electrical network and in doing so, that the allocation 88% of communications costs to Standard Control Services is both prudent and required.

3. Metering & Standard Control Services Data

This analysis requires that the utilisation of the AMI communications network needs to be attributed to two distinct purposes. The attribution model set out in Section 6 - Communication Data Modeling relies upon distinguishing the nature of data conveyed by the network. A characterisation of the data conveyed by the AMI Communications Network is made in the sections below and segregates to two groups: Metering Data and Standard Control Services Data.

3.1. Metering Data

This class of data includes the metrology data (including interval energy data, certain events) recorded by AMI Meters, as well as remote services for remote connection and disconnection of supply; and is directly related to the regulatory obligations of the MP, MDP, MC and LNSP. The timeliness, and reliability of this data is directly related to those regulatory obligations. Broadly characterised it is the data that measures the volume of energy (kWh) delivered through the distribution network to customers. Data collection schemes for metering data are oriented toward compliance with market obligations, nonetheless some peripheral use-cases related to customer data access benefit from increased collection frequency.

It should be noted that regulatory changes under the AEMC's 5 minute Settlement program will be increasing the volume of interval data retrieved over the AMI Network in the forecast period. The following proportions of meters delivering 5 minute intervals have been used for the allocation model:

Year	2021/22	2022/23	2023/24	2024/25	2025/26
30 Minute Interval Meters	100%	89%	86%	84%	81%
5 Minute Interval Meters	0%	11%	14%	17%	19%

3.2. Standard Control Services Data

A significant proportion of the data transferred across the AMI network relates to standard control services and is predominated by the collection of power quality data. At United Energy, CitiPower and Powercor that data includes instantaneous voltage, current, power factor and case temperature (meter model dependent) recorded at every AMI meter. These metrics are distinct from the energy-related metering data and capture both the quality of energy delivery to customers and in aggregate capture a vivid view of network asset conditions.

Samples of power quality data are generally recorded simultaneously across the meter population creating a virtual snapshot of the distribution network. These snapshots are taken relatively frequently (depending upon technologies employed either 5 or 15 minutes) and conveyed to central analytics systems.

Sample rates and delivery times are accelerated for small subsets of the meter population (down to 10s sampling and 1-minute retrieval) to provide additional clarity or support control functions that require near real-time feedback.

The volume of data retrieved from AMI meters varies by meter type according to the table below. For example, a three phase meter will capture three voltage measurements (as distinct data channels) corresponding to each phase compared to a single phase meter that will have only one voltage channel.

	Single Phase Single Element	Single Phase Two Element	Three Phase Direct Connect	Three Phase Current Transformer Connected
Voltage Channels	1	1	3	3
Current Channels	1	2	3	3
Power Factor Channels	1	2	3	3
Temperature Channels	1	1	1	1

3.3. Meter Population

The population of meters delivering both Metering and Standard Control Services data is set out below with the proportion of meters subject to various cadences of power quality data capture and collection according to the table below:

Power Quality Data Capture Frequency	Data Collection Latency	Meter Population	Proportion of Network	Usage
5 minutes	15 minutes	CitiPower: 336,555 Powercor: 893,270 United Energy: 683,450	100%	General baseline for power quality data collection
60 seconds	5 minutes	CitiPower: 33,655 Powercor: 89,327 United Energy: 68,345	10%	Enhanced collection specification for “meters of interest”
10 seconds	5 minutes	CitiPower: 1,683 Powercor: 4,466 United Energy: 3,417	0.5%	Upper envelope of capture capability for limited periods of time for special cases.

SensorIQ Performance Target

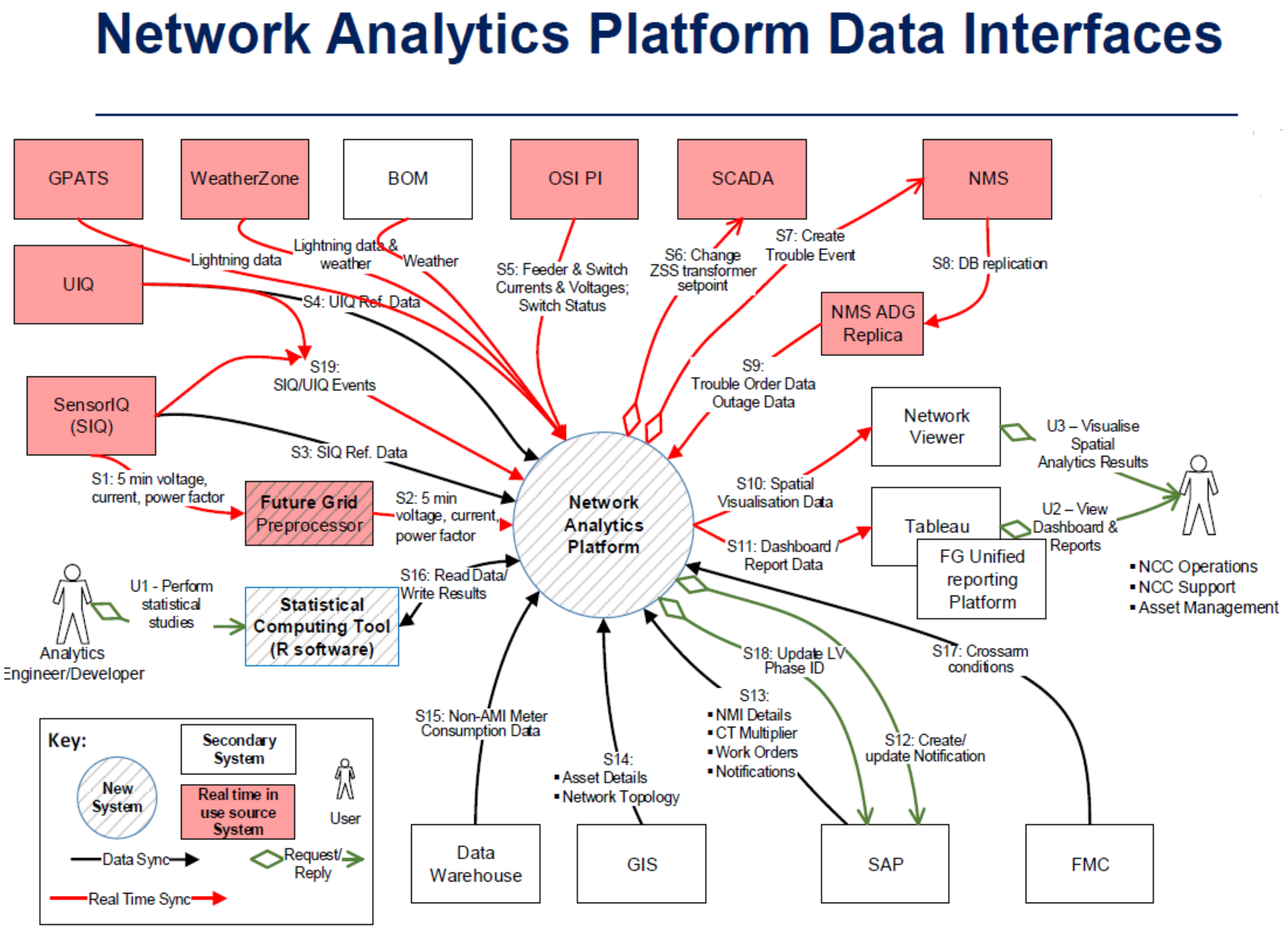
4. Establishment & use of Network Analytics

For both United Energy and Victorian Power Networks, large scale computing systems have been combined with collection of AMI Meter power quality data Metering data, SCADA and other enterprise data services to form a near real time network analytics environment at each distribution business.

Near real time metering data has become highly integrated with other Standard Control Services business systems and the operation of these systems are now dependent on this data.

The use of near real time power quality data has facilitated a number of use cases (see Section 5) that has improved the efficient and safe operation of the network and provided material consumer benefits.

The diagram below sets out a logical view of the inputs to the analytics platform among which are the UIQ and SensorIQ components – which broadly are the data collection systems for Metering data and power quality data respectively.



Developments in technical capability of systems are increasing the opportunity to deliver near-real-time control services. The highlighted componentry in the diagram above is already operating with sufficient low latency to contribute to near-real-time control functions.

5. Use Cases for Standard Control Services Data

The following table sets out a catalogue of functions delivered by the Network Analytics Platform set out in Section 4. Each use case is sensitive to a differing degree on the speed and completeness of data collection of power quality data from meters in the AMI network. The data collection methods implemented by each system and delivering into the platform establish a foundation upon which the use-cases or functions are delivered.

The AER Response suggests that a 1% sampling approach would be sufficient for the delivery of services. Adopting a sampling approach would alter the foundational data services upon which the functions (set out below) rely. The sensitivity to adopting a sampling approach is stated as an impact to service delivery and is itemised in the table below. The most sensitive function is Loss of Neutral detection and a full exploration of that function's characteristics is set out in Section 5.1.

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
Loss of Neutral	Detection of high impedance network faults most likely attributed to neutral conductor issues (corrosion, loose connections, etc.)	Power Quality Voltage Current	Min 5 mins 10 second data req ad-hoc	100%	Fewer EWOV complaints	Reduced occurrence of electric shock	Loss of neutral is detected in < 10 mins using current polling technology / regime Significant risk if issue not resolved fast	Safety compromised Reducing the sampling size would result in customer Loss of Neutral issues not being detected. i.e. a 1% sampling size would only detect 1% of Loss of Neutral issues. Reducing the sampling frequency would result in the customer potentially being exposed to a hazardous condition for longer
Meter Bypass / (Theft Detection)	Detection of bypassed meters at customer premises	Power Quality Voltage Current Customers on same circuit	5 min	100%	Less potential for unsafe network connections	Increased safety of network	Requires all meter data for all customers on a circuit to enable identification of meter bypass attempts	Safety compromised Reducing the sampling size would result in customer meter bypasses not being detected. i.e. a 1% sampling size would only detect 1% of Meter Bypass issues. Reducing the sampling frequency would result in the customer potentially being exposed to a hazardous condition for longer

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
Realtime Voltage Management	Realtime zone substation voltage set point control to maintain voltage compliance. Potential to participate as either RERT (Reliability and Emergency Reserve Trader) or FCAS (Frequency Control Ancillary Service) to the NEM	Voltage	5 min	100%	Less Voltage complaints, Better Voltage compliance Potential RERT or FCAS business income	Increased solar penetration Improved Voltage compliance Improved reliability NEM Operations (for RERT and FCAS services)	Sampling of all customers is required to increase assurance of compliance. AER requirement to report on Voltage compliance for each customer	Reliability at risk. Reducing the sampling frequency would impact the ability to manage voltage in near real time and expose the customer to unnecessary high or low voltages and potentially curtail their solar generation. Reducing the sampling size (whilst possible) would degrade the accuracy of our near real time voltage monitoring which relies upon generating a histogram of all customer voltages under a transformer and maximising the customers with voltages within code.
LV Network Fire Prevention	Detection of Network asset defects	Power Quality Voltage Current Alarms	5 mins 10 sec ad-hoc	100%	Asset Fire start reduction	Improved quality of supply	Polling of all customers is required as fast detection times are important to reduce fire starts. Fire starts could occur anywhere on the network; thus all points need to be monitored regularly	Safety Compromised Reducing the sampling size would result in customer issues not being detected. i.e. a 1% sampling size would only detect 1% of customer issues. Reducing the sampling frequency would result in the customer potentially being exposed to a hazardous condition for longer
Phase Identification / LV Mapping / Cross reference	Detection of LV customer connectivity to network	Power Quality Voltage Current	5 mins	100%	Reduction in customer non-notifications for planned / unplanned outages	Reduction in unexpected outages Improved notification of planned outages	This is error detection in the network model. Benefits of the precision of the network model dependent on constant and full data sets	Reliability at risk. Compliance risk Reducing the sample size would prevent the correct mapping of customers to phase and to network assets. This information is critical for outage and load management. SCADA / ADMS and GIS all rely upon an accurate network model which is maintained by this use case.

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
								The frequency of data collection could be reduced but at present this uses data gathered for other use cases.
Load Unbalance Detect	Detection of unbalanced load at the LV connection level	Power Quality Voltage Current	5 mins	100%	Voltage Compliance Solar Tripping Issues PQ Reduction in outages	Increased solar penetration Improved PQ Reduction in outages	Sampling of data does not provide visibility of customer loads across all substations. Load Balancing cannot occur without full visibility to all data	Reliability at risk Reducing sampling size would not allow aggregating all individual loads and the subsequent balancing of asset loads leading to premature asset failure, fuse blows and unsafe conditions. The difficulty in reducing the sampling frequency is that there are critical periods (extremely hot days etc) where high resolution data is required
Non-Compliant Solar Suite	Detection of Customers with Solar Connections that are not; Registered as Solar Customers, are exporting more than Contracted to export, Have incorrect settings on their solar inverters.	Power Quality (Voltage, Current)	5 mins	100%	Voltage Compliance Reduced Complaints Increased Solar Penetration	Increased Solar Exports for permitted customers Less solar issues.	Without PQ data, the detection of customers who are not compliant is impossible to detect. Sampling also does not allow detection of customers that are exporting incorrectly (Excess or Incorrect Inverter Settings) as these customers would need to be in the sample taken.	Reliability at risk Incorrect solar rebates to customers Inverter overload a safety risk Reducing the sampling size would result in issues not being detected. i.e. a 1% sampling size would only detect 1% of issues. Reducing the sampling frequency would compromise the ability to detect incorrect inverter settings etc.
Broken Conductor Detection	Detection of Network	Meter Alarms, Channel Alarms Power Quality (Voltage, Current)	5 mins / 10 Second	100%	Improved Safety outcomes. Reduction in outage Duration	Improved Quality of Supply	Real Time monitoring of network conditions ensures that timely detection of network abnormalities and faults can occur.	Reliability Requires all customers in near real time to assist in fault location via voltage profile

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
SWER Line Monitoring	Detection of Network	Meter Alarms, Channel Alarms Power Quality (Voltage, Current)	5 mins / 10 Second	100%	Improved Safety outcomes. Reduction in outage Duration	Improved Quality of Supply.	Real Time monitoring of network conditions ensures that detection of network abnormalities and faults can occur.	Safety Compromised The sampling rate could be reduced and changed to rely upon alarms and meter pinging. This use case, however, uses the data collected for other use cases.
Faulty Meter Detection	Detection of Faulty Meters	Meter Alarms, Channel Alarms Power Quality (Voltage, Current)	5 mins / 10 Second	100%	Improved Quality of Supply. Move to reactive rather than scheduled Replacement of meters	Improved Quality of Supply. Reduction in Billing errors.	Replacements of meters have the potential to become costly into the future, by using Alarms and Events and meter data we can detect meter issues as they occur rather than waiting on customer complaints or billing errors to occur.	Customer Focus compromised Reducing the sampling size would compromise the detection of faulty meters. Reducing the sampling frequency would result in the customer having a faulty meter for a longer period.
Auto job issuing: meter faults	NA	Meter Alarms, Channel Alarms Power Quality (Voltage, Current)	5 mins	100%	Auto-detection of faults	Faster resolution of faults Preventative maintenance		Increased customer complaints Reliability at risk Resource overload
A/C Detection	Detection of A/C units to stabilize load during peak demands This use case specifically identifies this type of load which is important for forecasting purposes	Power Quality (Voltage, Current)	5 mins	100%	Proactive prevention of network outage due to overload	Continuous power to run A/C		Reliability compromised Reducing the sampling size would fail to detect connection of large Air Conditioners to the network. Visibility of these large loads is critical for network planning and asset protection. Reducing the sampling frequency is possible, but need to capture hot days when customers are home and then also baseline days to be able to do comparisons

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
Phase Rebalance new Connection	The ability to place customers on the correct phase at the time of connection reduces the chance of overloads due to the connection occurring on which ever phase a line worker wants to connect to.	Power Quality (Voltage, Current)	5 mins / 10 Second	100%	Improved Quality of Supply. Reduction in Network Outages.	Improved Quality of Supply. Reduction in Network Outages.	Detection of network growth. Without real time monitoring overloads cannot be reliably detected.	Reducing sampling size would not allow aggregating all individual loads and the subsequent balancing of asset loads leading to premature asset failure, fuse blows and unsafe conditions.
Summer Saver / Energy Partner Program	Near-Realtime load management program to manage customer Distributed Energy Resources (DER) (e.g. A/C) to avoid asset constraints	Power Quality (Voltage, Current)	5 mins	100%	Reliability improved	Commercial benefit		Reducing the sampling frequency or size would compromise the ability to detect asset constraints and manage customer Distributed Energy Resources (DER) such as air conditioners to reduce these asset constraints. Using near real time load forecasting (which uses near real time AMI data) for managing customer DER is critical as greater emphasis is put on demand side solutions Managing customer DER is small at present but increasingly rapidly.
Self-Serve Portal	Visibility of Network Loading, Phase imbalances enables more efficient planning to occur.	Power Quality (Voltage, Current)	5 mins / 10 Second	100%	Improved Quality of Supply. Reduction in Network Outages.	Improved Quality of Supply. Reduction in Network Outages.	Detection of network growth. Without real time monitoring overloads cannot be reliably detected.	This is an internal self serve portal for network planning, claims investigations and customer services. Need near real time data from 100% of customers to cover all potential uses of the data. For example if customer calls in complaining of voltage issues, need near real time data to be able to offer assistance.

Use Case	Description	Data Required	Frequency Required	% Sampled	Business Benefit	Consumer Benefit	Comments	Sampling Impact 1%
								The meter itself only stores 5 days of 5m data. And 8 hours of 10s data so this needs to be retrieved and stored. If for example only 1% of meters were sampled (on a rotating basis) then 95% of data would be lost within 5 days.

Important Use Cases with further detail

5.1. Loss of Neutral

5.1.1. Overview

The loss of neutral integrity of the electricity supply to customer premises can result in the presence of hazardous voltages on conductors that ordinarily lie at earth potential. In certain fault conditions (and depending on safety earth wiring) customer plumbing can become energised and present a shock hazard to customers. Over the last five years United Energy, CitiPower and Powercor have developed and continue to refine systems and business processes to continuously monitor the condition of power supply to each customer. Among other capabilities these systems operate as rapidly as possible to detect hazardous degradation of neutral integrity and proactively interrupting supply to mitigate shock risk.

5.1.2. Detailed Description:

The technical operation of the system relies on measuring instantaneous current, voltage and power factor at 5-minute samples (or higher) at each AMI Meter and conveying these to an analytics platform as rapidly as practical for processing. Analytics platforms process the data (taking advantage of the variability of customer loads and the availability of neighbour data and other live network conditions) to infer network impedance as seen from the AMI Meter. Refinements to the system's speed and accuracy include the recording of 10s power quality samples at each AMI meter for on-demand retrieval and processing (if other indicators flag a possible hazard) and improvements to the variety and accuracy of fault conditions that can be detected.

Figure 1 - Network Fault Photographs

Once detected and depending upon detection confidence, fault severity and shock risk; business processes are enacted to treat the hazard. The most serious hazards that present a shock risk to customers are treated by interrupting supply using remote operation of the AMI Meter's supply contactor.

5.1.3. Sampling Vs Whole-of-Network

Neutral fault integrity hazards can emerge at any time anywhere in the distribution territory with no warning. Following the emergence of a hazard a race condition occurs between the distribution business' detection/treatment process and a customer shock incident. The total time taken between the emergence of a hazardous fault and its treatment has a direct bearing on the incidence of customer shocks. **Minutes matter**. The design target for the business processes to detect and treat faults is **under two hours**. However, in most instances, the technical support teams react in minutes.

There have been incidents where the LoN fault was detected and the dispatch crew was prioritised to resolve the issue safely and speedily, however the customer had unfortunately received and shock before the maintenance crew arrived to fix the situation. In these cases, the ability to **automatically** turn off the power using data-driven workflows to proactively protect the customer from shock is a key benefit of having low-latency (near-real-time) access to the data from the network

A comparison of United Energy customer shock incidents over the prior decade shows a significant reduction that is attributable to the safety hazard treatments stemming from the introduction of whole-of-network PQ data analytics in 2016 from approximately 70p.a. (2010-2015 average) to a 2020 trend expected to be under 20p.a.

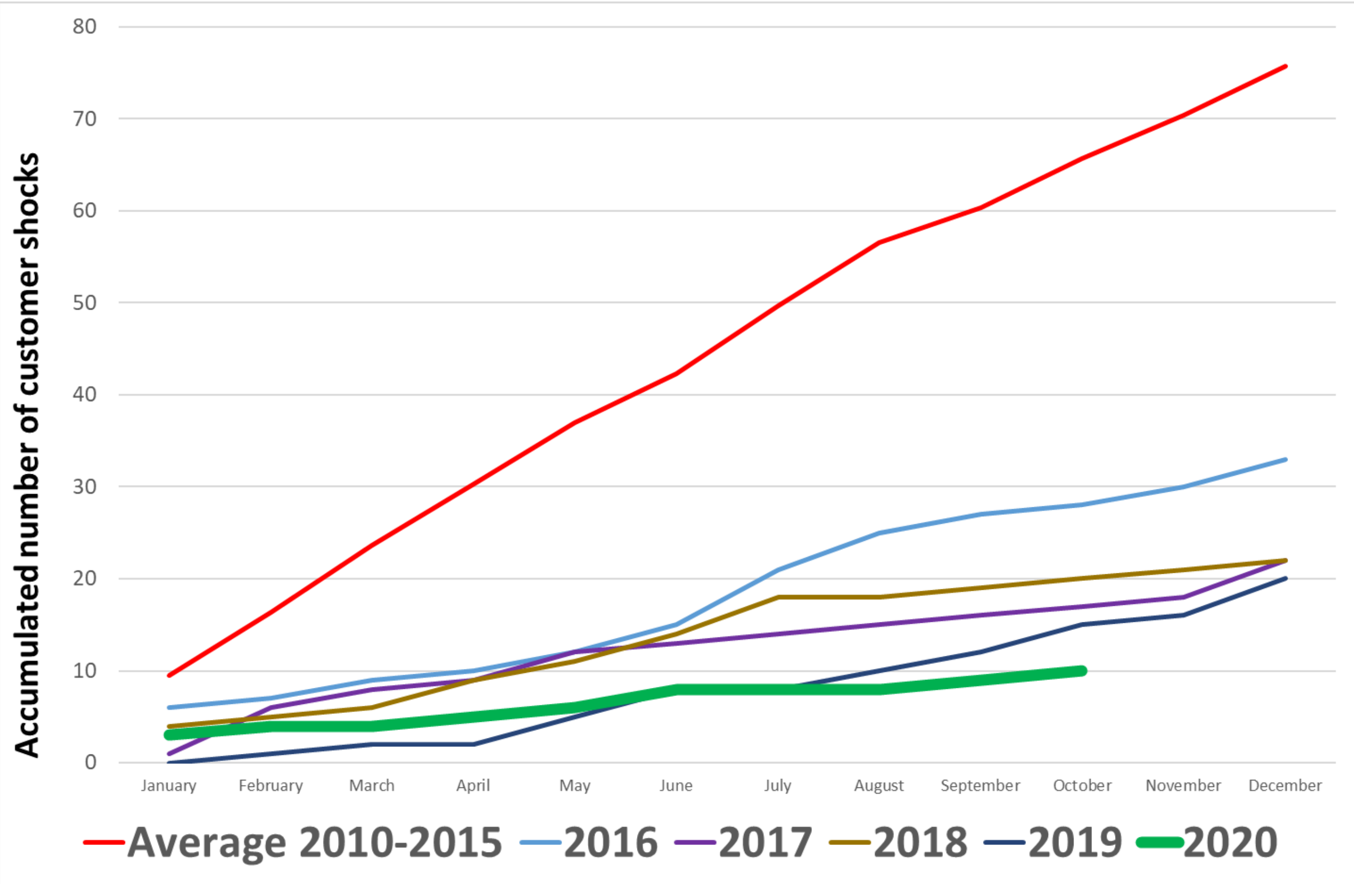


Figure 2 – United Energy Customer Shock Incidents (Calendar Year Accumulating)

Accumulated number of Customer Shocks:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	8	15	26	40	50	58	65	74	79	89	94	96
2011	5	14	18	20	23	24	30	41	43	48	52	60
2012	7	11	19	27	33	37	42	44	46	49	53	61
2013	9	18	4	34	41	47	54	63	67	72	79	83
2014	12	13	18	19	21	23	31	35	40	43	46	48
2015	6	7	8	10	14	22	28	31	35	38	43	46
2016	6	7	9	10	12	15	21	25	27	28	30	33
2017	1	6	8	9	12	13	14	15	161	7	18	22
2018	4	5	6	9	11	14	18	18	19	20	21	22
2019	0	1	2	2	5	8	8	10	12	15	16	20
2020	3	4	4	5	6	8	8	8	9	10		

The combination of systems and processes avoids approximately 50 customer shocks p.a. (United Energy) or alternatively an approximate **70% reduction** in annual customer shock rate. CitiPower and Powercor are in the process of implementing the same system as United Energy to detect and treat neutral integrity faults but nonetheless have an existing whole-of-network analytics system that operates with longer latency (CP/PAL 12h Vs UE 15 minutes) and lower sampling rates (CP/PAL 15 minutes, UE: 5 minutes/10s). CitiPower and Powercor's current annual shock rate is approximately 130 p.a and is expected to fall to 40 p.a. with the adoption of the same technology as United Energy.

The AER proposes that a targeted sampling of 1% of meters would be sufficient to assess the condition of network assets. Such an approach to asset condition monitoring would leave 99% of meters unmonitored for faults developing on the customer service line or metering installation. Conceivably the sampling could be rotated through the meter population on a random or round-robin approach to create 100% coverage over a rotation period however this introduces latencies that would impact detection probabilities and response times to treatment. The static sampling approach would leave 99% of customers unprotected by the Loss of Neutral scheme so a rotation approach is proposed to understand the impact of reducing collection frequency to once per day per meter (1.04% of the rate of collection) on both customer impacts and the balance of Metering and Standard Control Services traffic.

Degradation of system capability through rotating collection is likely to have a disproportionately high detrimental impact on system effectiveness for shock prevention because the measurement of impedance relies upon load variation; Continuous all-of-network monitoring greatly improves the probability that load-variations are visible to the analytics platform in the critical time following the emergence of a fault.

Re-design of these systems to use a sampled (or rotational) approach suggested as sufficient by the regulator would degrade each business' capability to detect (and treat) the emergence of faults with sufficient speed to avoid a customer shock in approximately 1-(Sample Rate) cases. Applied to UE; With a 1% sampling rate, hazardous faults may (eventually) be found by a random or round-robin sampling system however (with average latency increased ~100 fold from 15 minutes to 24 hours) they would be unlikely to be detected in an estimated 50 cases p.a. before the customer experiences a shock.

Loss of Neutral Detection Customer Outcomes Average Customer Shock Incidents Per Annum	All-of-Network	1% Sampling (Rotated)	50% Sampling (Rotated)
United Energy	~20 p.a.	~70 p.a.	~45 p.a.
CitiPower and Powercor	~40 p.a.	>130 p.a.	~85 p.a.

5.2. Meter Bypass (Theft Detection)

Description:

This describes the situation that arises when consumers have deliberately tried to bypass the installed meter. This exposes the consumer to physical injury risks as it is likely that unqualified and unlicensed people have installed the circuits that would bypass the meter/s.

Meter Bypass can cause house fires.

The images below highlight the issues in the field that are being detected and mitigated through the use of our Network Analytics Platform.

A daily sample of all meters would be sufficient to further mitigate this risk.

5.3. Realtime Voltage Management Use Case

5.3.1. Overview.

The optimal voltage for single-phase households is 230V, with tolerances of -6% → +10%. When the voltage falls outside these parameters, it can lead to damage to appliances. This is turn could lead to claims on the LNSP. This situation could be mostly avoided by knowing exact voltages are monitored and an out-of-range voltage that persist can be proactively addressed.

With the steady implementation of smart grid technologies throughout the network, the online voltage control can be achieved ensuring the power quality and voltage levels within the statutory limits.

This issue affects reliability of service. As the demand in the grid fluctuates depending on a number of factors, it becomes increasingly important that monitoring systems are enabled to react in ways that will ensure the load can be stabilised and controlled dynamically.

High voltages can also potentially curtail solar generation and near real time voltage management is required to maximise the use of solar generation.

5.3.2. Sampling Vs Whole-of-Network

Sampling and monitoring of anything less than 100% of the network will lead to a risk of service reliability and potentially safety issues. It would also very likely see a significant increase in customer complaints. To take advantage of smart distribution and optimisation, as much of the network needs to be monitored as possible. Reliability can be put at risk if excess solar penetration overloads the distribution substation leading to supply outages and reliability is at risk if wholesale market or distribution system demand overload cannot be managed through voltage management.

5.4. LV Network Fire Prevention

5.4.1. Overview.

The emergence and availability of evolving technology solutions for network monitoring should trigger the reassessment of what is reasonably practicable to manage safety risks to the level reasonable and practical levels. It should be assumed that general maintenance is labour intensive and therefore impracticable and not a cost-effective use of resources. With the number of physical assets deployed, it is not practical to replace old equipment based on the age of the equipment alone, but also on being able to detect when the equipment is not acting in accordance with the operational specifications. Even new equipment is subject to failure and wear.

Since the technology to actively monitor equipment is available and currently in use, it would create a better environment for safety and active fire prevention if the data from the various assets deployed was used in near-real-time to proactively reduce the possibility of fires. This becomes even more critical in the warmer months where bushfire risk is elevated.

Note that no verifiable data on the incident frequency of charring and/or fire outbreaks was available at the time of writing.

5.5. Use Cases by Function

5.5.1. Safety

First and foremost, it is the goal of a network business to eliminate / minimise any issue that could lead to injury. This includes electrical shock and fire damage. When a condition is identified, timing is critical and minutes matter. By not monitoring the entire network, in near-real-time (5-minute intervals), the risk of shock increases considerably, as shown by the previous use cases related to Loss of Neutral.

Network overload can occur randomly as the network is continually experiencing ebbs and flows in demand and this demand needs to be balanced with available capacity. As parts of the network overload, the risk of equipment overheating and subsequent fires increases.

For purposes of safety, a sampling rate of 1% poses an unacceptable risk to consumers and maintenance staff.

Use cases that are related to safety include:

- Loss of Neutral
- Meter Bypass
- LV Network Fire Detection
- SWER Line Monitoring
- Broken Conductor Detection
- Non-Compliant Solar Suite

5.5.2. Reliability.

Having a reliable, predictable electrical energy supply is the stated duty of an electricity distributor to the customer. To this end, it is important to quickly detect conditions which may affect the reliability, analyse the situation and take corresponding and appropriate action.

Use Cases that are related to reliability include:

- Realtime Voltage Management
- Phase Identification / LV Mapping / Cross reference
- Load Unbalance Detect

5.5.3. Business Efficiency

Several use cases of having access to a full set of low-latency data can result in better economic outcomes for customers. Limiting the data available would lead to increased customer costs. These use cases are:

- Battery Detection / AC Detection / EV Detection
- Summer Saver
- Auto job issuing: meter faults

5.5.4. Customer Focus.

It is also important that customers / consumers are supported and have the best available service in case of emergency and restoration of power from power outages. This reduces the occurrence of customer complaints and also allows the service providers to proactively streamline services provided.

Having information from all customers in near real time allows the distributor to minimise outages, improve customer restoration times, maximise customer safety, reduce long term costs by prudent network planning and responding to emerging trends such as an increasing penetration of solar, EVs, battery storage and being able to accurately forecast demand to manage beyond the meter Distributed Energy Resources. Reducing the sampling size or sampling frequency of meter data would have material customer impacts and erode gains made in previous periods.

6. Communication Data Modeling

The AMI communications network needs to have an attribution model applied to its usage for the purpose of apportioning network utilisation to ***Metering*** Vs ***Distribution Network Management***. This report uses a data volume model to best understand how each apportions network utilisation and more importantly how they align and/or differ. It is noted that the AER Response did not object to the model used to apportion communications network usage but did focus on the variables driving the model; in particular the breadth of power quality data collection suggesting collection of power quality data from 100% of the meter network was over-collecting and that a 1% figure was more appropriate.

The output of that model arrived at the following balance of network utilisation:

Metering	12.4%
Standard Control Services	87.6%

6.1. De-rating Power Quality Data Collection

Section 5.1 explores the Loss of Neutral function and sets out that collection of power quality data is necessary from all AMI meters to support the function. Nonetheless a de-rating of the system by reducing collection frequencies to ~1% and 50% of its previous rate is studied (and presumably accepting a consequential rise in the incident frequency of customer shocks) and modelled using the previously submitted method.

The input variables altered in the attribution model are set out in the table below.

	Original Model	**De-rated Model 1% Rotation (Daily Collection)**	**De-rated Model 50% Rotation (Half-hourly Collection)**
PQ Read – Collection Frequency (minutes)	15 minutes	1,440 minutes (daily)	30 minutes
PQ Read – Bytes Per Transaction	48 bytes	4,608 bytes	96 bytes

It should be noted that the payload size (Bytes per packet) increases proportionally as the collection frequency is reduced however efficiencies are gained in the overall model as there is less collection overhead. The output of the varied model (in comparison to the baseline case is set out in the table below:

	Original Model	**De-rated Model 1% Rotation (Daily Collection)**	**De-rated Model 50% Rotation (Half-hourly collection)**
Metering Data	12.4%	26.6%	17.0%
Standard Control Services	87.6%	73.4%	83%

De-rating of the system by reducing data collection frequency from 15 minutes to daily reduces the balance of Standard Control Services traffic by 14.2%

It should be noted that the de-rating of this safety system is not recommended; the proposed de-rating option was modelled to understand the sensitivity of attribution to conceivable changes in the power quality data collection scheme.

7. Conclusion and Recommendations

United Energy and CitiPower and Powercor have made significant strides in the use of metering data to improve the safe and efficient operation of the electrical network.

Both companies have invested heavily in the develop of network analytics platforms and use cases that provide material benefits to consumers (over and above the simplistic use voltage use case noted by the AER).

These use cases require data collection from all meters at higher frequencies that stated by the AER. If the number of meters or the frequency of polling were decreased there would be material safety and other considerations that would need to be considered.

Combining the concepts set out in sections 5 and 6 establishes the possibility of reducing the proportion of network usage attributable to Standard Control Services however this comes at the cost of de-rating the performance of a number of functions; most notably the delivery of rapid Loss of Neutral detection and treatment. The customer-facing consequence of derating that specific control service is a tripling of the electric shock incident rate at each distribution business.

	Original Model (Recommended)	**De-rated Model 1%**	**De-rated Model 50%**
Metering Data	12.4%	26.6%	17.0%
Standard Control Services	87.6%	73.4%	83.0%
Electric Shock Incidents (predicted average annual customer incidents)	UE: 20 CP/PAL: 40	UE: 70 CP/PAL: 130+	UE: 45 CP/PAL: 85

The de-rating of the system (by reducing collection frequency) has a significant detrimental impact on customer service outcomes (a tripling of customer shocks) yet only a 14.2% shift in the proportion of traffic attributable to Standard Control Services. Even a relatively light (50%) de-rating of the system (to half-hourly collection (from 15 minute) is still expected to double the shock rate due to the time-sensitivity of detection and treatment.

It is recommended that the model for network cost attribution set out in the [original submission] is retained as the consequences of adopting a de-rated approach to the collection of power quality data and delivery Standard Control Services (including safety services) appear to outweigh the benefits.

It is believed that the AER may not have fully understood the technical characteristics of these relatively new Standard Control Services at the time of their review of the submission and it is recommended that the material of this report be considered before making a final determination.

8. References

Document Reference	External Reference
1	AER DRAFT DECISION : Powercor Distribution Determination 2021 to 2026 Response par 16.3.4.3
2	AER DRAFT DECISION : Powercor Distribution Determination 2021 to 2026 Response table 16.4

9. Profiles

This report was prepared by Ferenc Mantfeld and Paul Staugaitis, with assistance and review by Kevin Webster, from Operational Technology Solutions (OTS).

Consultant Profile for Ferenc Mantfeld

Senior Solutions Architect
Data Management / Performance Analytics / Business Intelligence

Ferenc is a creative and innovative thinker with over 30 years' information technology experience, and 25 years' data management experience. He has expertise in data management, retrieval and visualisation, with the innate ability to provide a new perspective on customer problems.

Author, speaker, presenter, technical instructor, trusted advisor, blogger. A proven self-starter, innovative and driven leader. He has many years' experience managing successful IT business, demonstrated business acumen, a technical and entrepreneurial mindset, along with essential insight into the business needs of marketing, sales, education and HR.

PROFESSIONAL STRENGTHS INCLUDE:

- Strategic Planning & Execution
- Influential Leadership
- 3rd Party Vendor Management
- Stakeholder Management
- Product & Enterprise Solutions
- Information Security
- MDM (Master Data Management)
- Data & Information Governance
- Project & Initiative Implementation
- Large Scale Data Infrastructures
- Roadmap Definition & Delivery
- Cloud Computing (AWS, Azure)
- Advanced SQL
- Cross Functional Initiatives
- Infrastructure Design
- Analytics
- Data Integration
- Team Leadership
- Client Centric IT Strategy

EDUCATION

MBA (Supply Chain & Logistics track) - *AIB*

Bachelor of Science (Computer Science) - *Houston University*

Graduate Diploma Business Administration

Certified Data Management Professional

SELECTED CAREER HIGHLIGHTS

- ✓ Designed & built a very robust and feature rich tactical BI & ETL tool, still in use by large corporations
- ✓ Created & taught Advanced SQL curriculum worldwide, helping hundreds of developers with advanced SQL
- ✓ Wrote and published a book: "Lifting the Fog on Business Intelligence"

Experience

Enterprise Architect (Information Management) 2020

Provided Strategy and Architecture, responsible for the IM domain. Assisted with Enterprise Data Governance Initiative. Planned 5-year architecture road map in terms of DW, integration, Analytics, security, IoT event streaming.

Senior Solution Architect 2017 – 2019

Solution architect dealing with digital transformation using IoT sensor data. Ingesting 300M rows per day of gas well performance data, designing scalability and fault-tolerant time series data for machine learning, data science complex algorithms to predict component failure and optimise gas throughput. Integration with AWS (Ec2, S3, SQS, Kinesis, Lambda, etc.), Azure, Google Cloud, Kafka, Python, Snowflake, Swagger API.

Chief Data & Analytics Officer 2015 – 2017

Headed up integration of analytics platform; initiatives in data integration and delivery of data visualisation. Provided technical leadership in the design of new solutions for the integration of corporate performance; applying knowledge of data integration, data warehousing, and data acquisition, scaling up infrastructure. Created and oversaw the implementation of ideas to successful integrated and repeatable, scalable solutions, and deployed across multiple customer environments.

Key Achievements:

- Introduced data bureaux approach to workforce management market; resulting in closer collaboration between three previously siloed departments.
- Implemented notification system for data quality issues; system recorded and notified upstream stakeholders when data found that did not match master data management definition or in breach of the stated business rules.
- Applied planning, implementation and control activities for data quality management; improved and ensured reliability of data for use in decision making, publications and analytics.
- Implemented new technology initiatives; designed most aspects of data flow for People Analytics, full HR quality metrics system, oversaw engineering, implementation, customisation and support processes.

Company Owner - SeeMoreData Aug 2003 – Aug 2015

Key customers: Carlton & United Brewery, ANZ, Telstra, Retravision, Vic Dept. of Education and Toyota.

- Design and implementation of a proactive budget management system.
- Design of portal to enable supplier to self-monitor inventory and sales levels.
- Acquired and interpreted data from incoming CRM (Siebel) system.
- Implementation of BI system.
- Trusted advisor; delivered 11 projects successfully. Shared expertise participating on councils and management groups.

Consultant Profile for Paul Staugaitis

Technical Lead / Solution Architect / Strategist

A strong engineering leader with a broad range of technical experience from hardware and software application design, business analysis to enterprise computing system architecture. Broad and sound technical intuition, and drive to innovate is complemented by outstanding communication skills.

Paul has played a pivotal role in the successful rollout of over 1.5 million meters across Australia over the past 12 years and helped Australia's largest energy businesses adapt to modern cloud-based enterprise systems and the ecosystem of internet connected devices.

Paul has been the technical lead on several key utilities projects at CitiPower/Powercor, United Energy, AusNet Services, Jemena, Origin Energy and Energy Australia. At AusNet Services, his role was as Communications Specialist. At Jemena, he was the solution architect for the advanced metering infrastructure project providing technical consulting for mesh radio, 3G communications network and network management.

Paul has also been at the forefront of various communications initiatives over the years including analog and digital radio infrastructure, powerline communications, GPRS, GSM, IS-95 and 3GPP air interfaces, high dynamic range A/D conversion, smart antenna arrays, block frequency conversion and linear power amplification technologies.

Professional strengths include:

- Communications Systems Engineering
- Digital Content Management and Analytics Platforms on AWS
- Technically relevant information management policy development
- Extensive Utilities Experience including Electricity and Gas, Water, Mining
- Senior Utilities Consultancy Experience
- Contract Negotiation

EDUCATION

Bachelor of Engineering (Communications) RMIT 1996

Professional Experience Overview

Technical Lead – UIQ Upgrade / SIQ Implementation 2019 - present

Technical lead for delivery phase of an AMI system (Itron UtilityIQ) upgrade project including implementation of SensorIQ to deliver high performance neutral fault detection. Project scoping and high-level design co-ordination for analytics re-platform and an operational technology integration layer. A variety of highlights including diagnosis and remediation of root cause of a performance constraint, delivering a 40% improvement in data collection speed.

Technical Co-ordinator and AMI Specialist January - May 2019

Technical contribution and oversight of AMI System upgrade project. Design documentation, technical issue co-ordination and resolution. Led the development of a system to detect LV fuses at risk of operation and a novel protection scheme utilising smart meter network capability to maximise availability of customer supply during extraordinary peak summer load conditions.

Program Stream Lead – Power of Choice 2016 – 2018

Achieved compliance with Competition in Metering regulatory changes. Authored strategy for the retailer to comply with regulatory obligations (and change course from implementing its own Metering Co-ordinator). Established and led the metering stream of the Program as well as guiding the establishment of a new business unit to maintain metering provider contracts ongoing

Metering and Communications Specialist 2014 - 2016

Advanced Metering Infrastructure remediation program; implementation of a Silver Spring Networks mesh radio network. Provided specialist technical expertise and general written and presentation skills to vendor contract negotiation, system architecture and service transition activities.

Smart Capability Development Lead 2011 - 2014

Smart energy, engineering and digital technology subject matter expertise and consulting for the development of customer facing information systems. Applying specialist knowledge of home area networking technologies including Zigbee and smart energy metering to the design of web portals and other display systems.

Solution Architect 2007 - 2011

Advanced Metering Infrastructure technical consulting for the AMI Meter, Mesh Radio and 3G communications network and Network Management System.

Consultant Profile for Kevin Webster

Kevin has an extensive background managing complex programs in the Utilities industry. He is a highly successful Program and Project Manager with an impeccable reputation for on-budget, on-time delivery in the Operational Technology space. He has a deep understanding of electricity distribution and has provided consulting expertise to all the various programs and projects he has managed specifically in the areas of Advanced Metering and Control Systems technologies.

PROFESSIONAL STRENGTHS

- 20+ years AMI, DMS, OMS, SCADA and project management experience.
- Managed projects in excess of $50m.
- Impeccable record of on-budget and on-time delivery.
- Experienced in presenting to Executives (CEO level) and Senior Management.
- Strong SI Management and Contract Management experience.

Certified Project Management Professional (PMP) • Certified Master Project Director (MPD)
ITIL and PRINCE 2 Certified

EDUCATION

Master of Business Administration
Melbourne University

Bachelor of Science (Electrical / Electronic Engineering)
Graduated Cum Laude

PRIOR PRESENTATIONS

Itron World Conference in Arizona on the development of IoT based sensors

Smart Utilities (Australia and New Zealand) Conference in Sydney on the customer benefits of Smart Meters

Transmission and Distribution (Asia) Conference in Vietnam on Smart Grid and Smart Meters (voted in top 3 speakers)

Metering Europe Conference in Barcelona on Strategy, Architecture and Design associated with Smart Metering

Metering Asia Conference in Bangkok on Strategy, Architecture and Design associated with Smart Metering

Metering Australia Conference in Melbourne on Strategy and Architecture associated with Smart Metering

National SCADA Conference on DMS, OMS, SCADA and Communication Strategies

Relevant Experience

Project and Program Manager **2019 - Current**
Solution expertise, guidance for a major UIQ upgrade and SIQ implementation.

Project Manager, Digital Metering **2018 – 2019**
Responsible for the development of a Digital Metering Proof of Concept Strategy and Plan.

Project Manager, Advanced Analytics Program **2018**
Project Management services for the use of AMI and IoT sensor data (~500Tb) to support advanced use cases such as Theft Detection and Real Time Voltage Management.

Consulting and IoT Sensor Development **2016 – Present**
Oversee the development of the world's most advanced suite of sensors for Utilities including Line Monitors, Transformer Monitors, Demand Management and Water Metering Solutions.

Using LPWAN communication technologies (NB IoT, Cat M1, Itron mesh etc.) and open standards such as LWM2M, have developed (hardware and head end software) and delivered solutions to all Victorian Distributors.

For Victorian Utilities the advantage of these sensors is that they leverage the AMI communications infrastructure deployed as part of the AMI Programs.

Program Manager, Digital Metering **2016**
Digital Utility strategy, detailed specifications for meters, communications and head end systems

Senior Project Manager, AMI Remediation Project **2014 – 2015**
Technical evaluation of the existing solution against regulatory obligations. Determination of remediation scope and options.

Program Manager, Digital Metering **2009-2014**
Over a five-year period, managed the AMI Technology and Installation Services components (team of 20 – 40 resources and contracts worth $100m+) of a major SmartNet Program including:

- Development of the strategy, architecture and requirements for the AMI Technology and Installation Services components of the program
- Managed the multimillion dollar procurement process
- Developed the end-to-end Strategy and Architecture (from meter to market).
- Developed the AMI Technology detailed design and installation plan.