Digital Network

PAL BUS 7.08 - Digital Network - Jan2020 - Public

Regulatory proposal 2021–2026

CitiPower Powercor

January 2020

Contents

1 Overview

Business	Powercpr
Title	Digital Network
Project ID	PAL BUS 7.08 - Digital Network - Jan2020 - Public
Category	ICT capital expenditure - non - recurrent
Identified need	Over the 2021–2026 regulatory period, we: • need to improve the ways we combine and generate real-time, actionable insights from our data through analytics and implement more sophisticated monitoring and management capabilities so that we can run the LV network dynamically.
Recommended option	Option 2—technology plus targeted rollout of network devices
Proposed start date	2021/22
Proposed commission date	2025/26
Supporting documents	1. PAL MOD 7.12 - Digital network cost - Jan2020 - Public 2. PAL MOD 7.13 - Digital network Jacobs benefit - Jan2020 - Public 3. PAL ATT009 - Jacobs - Digital Network benefits - Dec19 - Public 4. PAL MOD 12.02 - Quoted services labour rate - Jan2020 - Public 5. PAL ATT167 - AEMO - 2019-20 integrated system plan - Dec2019 - Public 6. PAL ATT199 - Yale - EV half of new car sales in Norway - Jul2019 7. PAL ATT198 - SAPN - Draft plan - 2019 - Public 8. PAL ATT206 - AEMC - Network economic regulatory - Sep2019 – Public 9. PAL MOD 6.04 – Network comms – Jan2020 – Public 10. PAL MOD 7.01 - IT capex - Jan2020 – Public

This document provides an overview of our Digital Network initiative, the proposed technology solution, the approach used to quantify the benefits customers will receive under various implementation solutions and our recommended option.

Context

Distribution networks all over the world are going through some of their largest transformations in history.

While we have good visibility of the high voltage network, changing customer requirements, for example to participate in new demand management programs or to take up electric vehicles and batteries, require us to develop greater visibility of our low voltage (**LV**) network.

Change is also being driven by new technological developments that can give us greater insights about our network and our customers to solve new and existing challenges in more effective and cost-efficient ways.

Proposed solution

During the 2021-2026 regulatory period, we will implement more advanced technologies capabilities through Digital Network. This includes implementing more sophisticated analytical, monitoring and management capabilities in order to run the network more dynamically in real time (ie. operationalising the data).

This includes extending our coverage of Advanced Metering Infrastructure (**AMI**) network devices to our Type 1-4 contestable metering customers (**large customers**) and unmetered supply in a targeted rollout.

Approach

We commissioned Jacobs to quantify the benefits of three different implementation options to ensure we maximise the benefits to our customers. Jacobs' conducted an economic analysis to quantify the benefits of Digital Network to customers using a variety of internal data (eg. about the network, findings from current trials) and external data (eg. Australian Energy Market Operator (**AEMO**)).

Figure 1 Summary of investment options

Options	Options description
0. Baseline	Continue utilising AMI data through existing technology and receive base level of benefits
1. Digital Network Technology	Invest in new technology that provides greater network monitoring and control capabilities
2. Technology plus targeted rollout of network devices	In addition to rolling out option 1 technology, increase the current coverage of network devices to improve LV visibility

Source: Powercor

We also conducted internal analysis to explore the optimal rollout of network devices featured in option 2. Through this analysis, we have developed a targeted approach to roll out additional devices, allowing us to halve the cost of these devices compared to other options.

Customer initiatives and resulting benefits

Through Digital Network, we will be able to build on our existing AMI-initiatives to enhance our network efficiency and safety and provide customer's greater flexibility. Initiatives with associated benefits quantified by Jacobs include:

- **promoting electric vehicle uptake -** monitor and optimise electric vehicle charging to understand and estimate the impact of increasing demand on our network resulting from electric vehicle penetration
- **optimise load control of customer appliances** - optimising the use of existing hot water load and slab heating control and enabling new load control programs (eg. air conditioners and pool pumps)
- **enhance cost reflective pricing -** analyse existing and future AMI interval data to construct more effective time-of-use tariffs or demand management, to reduce peak demand and improve utilisation of our network
- **detect electricity theft** - identification of sites with bypass connections reducing theft, as well as identifying unregistered distributed energy resources (**DER**)

In addition to the cases with quantified benefits described above, Digital Network will also provide unquantified benefits including:

- **proactively managing asset failures** - resulting in less fire-starts, greater augmentation deferrals and avoiding replacement expenditure
- **avoiding overblown fuses** - improving phase balancing, allowing greater asset utilisation (and therefore reducing augmentation) as well as avoiding replacement expenditure
- **looking after vulnerable customers** - allowing us to keep more life support customers connected during emergency load shedding events and providing more accurate communications to customers of planned outages through more accurate mapping of customers to supplying LV transformers
- **keeping customers safe** - enhancing the effectiveness of the way we identify potential loss of neutral at customers' homes, which can pose major safety issues of electric shocks if left unchecked.

Results and recommendation

Results for options 1 and 2 spanning 2021-2040 are shown in table 1, which includes present value (**PV**) value of costs and benefits, the net present value (**NPV**), and the internal rate of return. Option 2 has the highest NPV and a strong internal rate of return (**IRR**), demonstrating that the cost of implementing this option is significantly outweighed by the benefits customers will receive.

Table 1 Results for options 1 and 2 for 2021-2040, $m 2021

	Option 1	Option 2
PV value of costs	35	44
PV value of benefits	139	185
NPV of costs and benefits at 2.75% real WACC	104	141
Benefit-cost ratio (NPV)	3.95	4.21
Internal Rate of Return	28.7%	30.6%

Note: includes capital expenditure only
Source: Jacobs, Cost Benefit Analysis for Digital Network Implementation (PAL MOD 7.13)

We recommend option 2. By taking advantage of new technology under option 2, we can deliver benefits to customers including lowering bills through deferring augmentation, introducing or modifying networks tariffs to better utilise the network and maintain supply quality in the face of increasing voltage and load volatility across the LV network.

The table below specifies our proposed investment over the 2021-2026 regulatory period. While this project also incurs operating expenditure, we propose to absorb these costs, given the importance of this project.[1]

Table 2 Recommended options 2 investment profile for 2021-2026, $m 2021

Network	Cost component	2021/22	2022/23	2023/24	2024/25	2025/26	Total
CitiPower	IT[1]	$2.8	$3.2	$3.1	$0.9	$1.2	$11.1
	Augmentation[2]	$1.1	$1.1	$1.1	$1.1	$1.1	$5.5
Powercor	IT[1]	$2.8	$3.2	$3.1	$0.9	$1.2	$11.1
	Augmentation[2]	$0.9	$0.9	$0.9	$0.9	$0.9	$4.7
Total		**$7.6**	**$8.4**	**$8.2**	**$3.8**	**$4.4**	**$32.4**

1. This involves the technology costs, as found in PAL MOD 7.01 - IT capex - Jan2020 – Public and CP MOD 7.01 - IT capex - Jan2020 - Public
2. This involves the network device costs, as found in PAL MOD 6.04 – Network comms – Jan2020 – Public and CP MOD 6.04 – Network comms – Jan2020 – Public
Note: numbers may not reconcile due to rounding; includes capital expenditure only.
Source: See footnotes 1 and 2 above.

Summary of supporting documents

The various artefacts that inform this project are described as follows:

- the context for this business case (i.e. the background and the identified need being met by Digital Network) are summarised in this document
- the scenario analysis of the rollout of network devices is contained in Appendix B
- a detailed description of the proposed technological solution and a roadmap for implementation developed with support from Litmus consultancy is detailed in Appendices C and D
- the Jacobs technical report that quantifies the benefits of Digital Network for customers under two implementation options is provided in attachments PAL MOD 7.13 - Digital network Jacobs benefit - Jan2020 - Public and PAL ATT009 - Jacobs - Digital Network benefits - Dec19- Public.

1 This operating expenditure is still included in Jacobs cost-benefit analysis (see attachment PAL MOD 7.13 - Digital network Jacobs benefit - Jan2020 - Public) to ensure that the business case is valuable to customers over the long term.

2 Background

Distribution networks all over the world are going through their largest transformation in history.

While we have always had good visibility of the high voltage network, we have relied on predictable customer load profiles to manage the low voltage (**LV**) network. However, changing customer requirements, for example the desire to participate in new demand management (**DM**) programs or to take up electric vehicles and batteries, require us to develop greater insight into our LV network to better manage power flows and load fluctuations. Through developing more dynamic and real time capabilities, we can continue to provide safe, flexible and affordable networks.

Change is also being driven by new technological developments that will allow us to gain greater insights about the network and our customers in order to solve new and existing challenges in more effective and cost-efficient ways.

These two trends create both opportunities and challenges. By building a digital network, we can make smarter decisions more quickly which will enable us to enhance safety outcomes, and support our customers as they increasingly adopt new innovations, all while keeping the costs of running the network low.

2.1 Enhancing our existing AMI-underpinned initiatives

2.1.1 Benefits of AMI

We have already commenced the journey towards our future network. Our rollout of AMI meters provides us with insights into the LV network unmatched throughout the rest of Australia.

During last 10 years we deployed approximately 1.2 million AMI meters across our networks.[2] These meters provide 30 minute interval energy data of our residential and small business customers to retailers and the wholesale market. They also provide 5-minute power quality information (i.e. of voltage and current) to our Network Analytics Platform (**NAP**) which has allowed the provision of a range of services including:

- automatic neutral integrity fault detection and issue of faults for investigation as well as automated supply disconnection in more severe loss of neutral cases
- cross-referencing of life support customers to distribution transformers
- near-real-time voltage control
- 'last gasp' and restoration notification
- demand management programs.

[2] We deployed approximately 880,700 AMI meters in Powercor, 335,000 in CitiPower.

Figure 2 AMI benefits delivered

CONNECT

Timely connection

Ongoing savings from remote meter read
Customers no longer have to pay for site visits for meter reads and tests

Streamlining connections
Our crews connect customers and install meters in a single appointment, rather than multiple visits

Reconnecting remotely
We can remotely reconnect a customer without having to visit the customer's site

Connecting solar
We can remotely reconfigure smart meters for solar exports

SUPPLY

Better electricity supply

Improving safety at customers premise
Smart meters can remotely identify neutral integrity issues in a customer's home that may have led to electric shocks

Integrating solar and batteries
Smart meters provide information to help us understand when it is safe for customers to export energy into the grid

Improving security
Smart meters can help us reduce load by managing voltage at times of peak demand, avoiding potential blackouts

RESTORE

Fix outages quicker

Shorter outages
Smart meters help us detect outages quicker, so we can get power back on for our customers in a shorter time

Rotating load in emergencies
Smart meters help us share and rotate energy among our customers in times of emergency. We can prioritise life-support customers and critical infrastructure in these cases

Identifying faults at home
Smart meters provide information on whether an outage is caused by the network or a customer's home

BILLING

Efficient billing

Real time usage
Smart meters give customers next-day insights into their usage patterns to help them manage their bills and consider different tariff options

Improved data accuracy
Smart meters provide more than 99% accurate data each day, minimising data errors

Notification if a meter fails
Customers are at less risk of a incorrect bill from a faulty meter, as we receive a signal early when a meter has failed

EFFICIENCY

Lower long-term costs

Reducing peak demand
Smart meters allow us to control and distribute load among customers efficiently to reduce peak demand and need for augmentation

Improving power quality
Smart meters allow us to monitor voltage and reduce any potential issues before they occur

Improved visibility
Smart meters provide us visibility of the majority of the low voltage network, including load data that distinguishes between different phases

Source: Powercor

Case study: using NAP to detect Neutral Integrity issues

CitiPower and Powercor have created programs which use an algorithm to identify potential loss of neutral at our customers' homes. These types of faults can pose a significant safety issue because current can be passed through pipes resulting in 'tingling taps' which could pose an electric shock risk. Our Meter Insights algorithm helps to lessen this risk.

This program was initiated in March 2018. Each night it checks the homes of all 1.2 million customers. The algorithm produces a report at 8am each morning and field crews are sent out to inspect any suspected faults that are picked up. From the program's inception to December 2019, CitiPower and Powercor have detected and resolved 522 and 1,683 deteriorated neutrals, respectively.

2.1.2 Gaps in our network visibility

A common misconception is that we have visibility of our LV network. Whilst we have visibility of our residential and small business customers through AMI, which makes up around 96% of our network, we do not yet have the capabilities to view this data continuously in real time. We also do not have the same visibility of other parts of the network in areas where AMI has not been rolled out, such as our Type 1-4 contestable metering customers (**large customers**) or unmetered supply (**UMS**).

As seen in the figure below, those connections are 'invisible' to us from a data perspective. The data we do receive from these sites is generally not of sufficient granularity, nor is it provided in real-time, which is a requirement for running a dynamic network. For example, the data we receive from our large customers does not include power quality data and the data we do receive arrives the following day or week.

Figure 3 Available network data

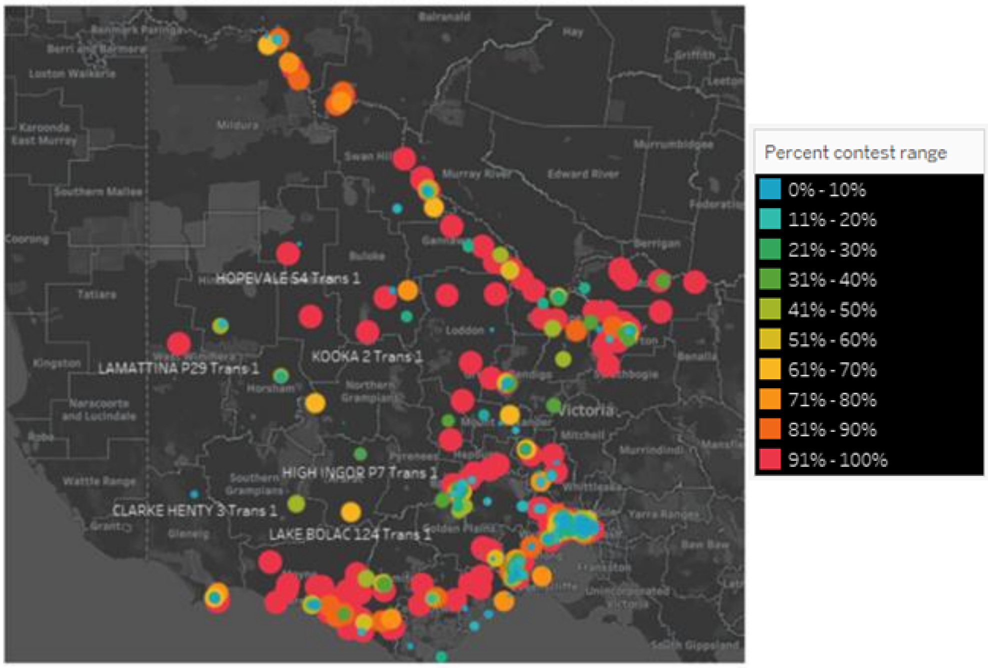
LV data availability checklist

AMI Customers		Distribution substations and phases	
• Usage/load	✓	• Usage/load	✗
• Voltage	✓	• Voltage	✗
• Current	✓	• Current	✗
• Real time capability	✗	• Harmonics	✗
Large Customers (LCs):		**Unmetered Supply :**	
• Usage/load – *provided next day or week*	✗	• Usage/load	✗
• Voltage	✗	• Voltage	✗
• Current	✗	• Current	✗

Source: Powercor

This invisible data can have significant impacts on our network. For example, contestable meters make up 1.3% of our customer base by volume, but contribute 39% of peak load on an average distribution transformer.

Figure 4 Proportion of Type 1-4 contestable load to total load per distribution transformer



Source: Powercor

We measure the electricity flow at the zone substation level, to ensure we have visibility of electricity imported we presently measure energy flows at the zone substation level, which measures energy we import from the transmission network. As part of this measurement process, we have established a number of IT systems to help manage our HV network in a real time such as our GE SCADA/DMS product PowerOn Fusion. We have not needed similar monitoring equipment on the LV network, which has been less complex to manage.

For the LV network we, instead use estimating methodologies to monitor loading. This approach has limitations, diminishing our ability to provide better network management including to:

- enable better network future planning
- avoid overloads to limit the occurrence of blown fuses and outages
- determine LV asset deterioration including transformers, feeders and service mains to improve customer, public and asset safety
- monitor LV power flows, which will become more challenging as consumers take up solar and battery systems in greater numbers.

Case study: distribution transformer overloading

In the summer peak on Sunday 28th January 2019 the maximum temperature reached almost 40 degrees with up to 92% humidity. During this time we experienced the highest ever Sunday maximum demand, driven by air conditioners (1,032MW and 2,195MW in CitiPower and Powercor respectively).

This resulted in 171 sustained outages affecting 49,365 customers in CP-PAL, with 82 outages due to load-related fuse blows at distribution transformers, due to the lack of full visibility on the LV network.

2.1.3 Preparing for emerging innovations

As new innovations such as electric vehicles, demand management and solar become increasingly prevalent on our network, this presents us with new opportunities and challenges in managing our LV network.

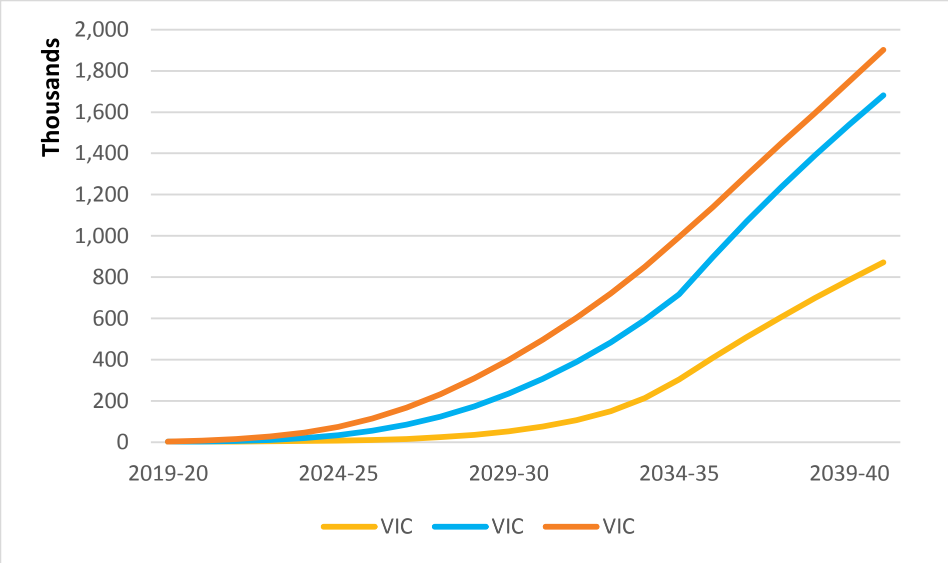
Electric vehicles

Growth in electric vehicle sales is forecast to increase in future. For example, AEMO's latest forecast suggests there will be nearly 56,000 electric vehicles in use across Victoria by 2026 up from around 2,500 today and increasing to 1.7m electric vehicles by 2040 under a central scenario.[3] Further, electric vehicle uptake is heavily influenced by government policies, so if future governments choose to create new programs to support electric Vehicles, uptake is likely to further increase. For example, the Norwegian government heavily invested in charging infrastructure and provided financial incentives, so that in 2019 electric vehicle accounted for nearly half of new car sales, up 25% from 2018.[4]

[3] See AEMO ISP 2019 Input and Assumptions workbook (PAL ATT167).

[4] Yale Environment306, EVs Make Up Half of New Car Sales in Norway So Far This Year, published at the Yale School of Forestry and Environmental Studies (11 July, 2019) (PAL ATT199).

Figure 5 AEMO modelling assumptions for EV uptake



Source: AEMO 2019, Assumptions and Inputs workbook

However without action, electric vehicle charging could prove detrimental network stability and security. Unchecked, peak demand would likely increase dramatically as electric vehicles add to existing network peaks between 7 pm and 9 pm. Electric vehicles can create great complexity and uncertainty on the network, given they do not remain stationary and may be charging on different parts of the network at different times. Given this, network costs could rise and if forecasting is inaccurate, may endanger grid operations.

Smarter solutions that rely on LV data visibility, complemented with tariff reform, are necessary if we are to avert future grid issues. Smarter solutions involving sophisticated capabilities require longer lead times hence it is important if grid costs are not to escalate, we begin rolling out solutions earlier than was the case for roof top solar.

Demand management

Increasingly consumers are actively managing their energy use through innovations such as demand management programs, where distributors incentivise customers to decrease energy usage during peak periods. Over the current regulatory period we have introduced a number of demand management programs, as shown in table 3.

The popularity and effectiveness of these programs continue to grow, with customer registrations growing on average by 61% each year while average demand reduction per customer per event growing 83% to 2.12 kW between 2017/18 and 2018/19.

Table 3 Current period demand management programs

Program name	Solution	Capacity	Target audience
Energy Saver (RACV Demand Response Trial)	Behavioural Demand Response. Partners: RACV & Local Councils. Sensibo thermostat device provides control load. Customers are compensated $20 per event. Reduce energy at risk on the Surf Coast and Bellarine Peninsula	2MW	Surf Coast Shire Bellarine Peninsula Residential customers
Smart Meter Voltage Management (**SMVM**)	Voltage management at a substation level to reduce network demand during peak periods. Vulnerable load and life support customers are closely monitored or excluded through events	60MW	Large electricity users with sophisticated energy management strategies

Source: Powercor

These initiatives today remain relatively manual processes, limiting our ability to scale demand management programs in future unless dynamic, real-time data processing capabilities are available.

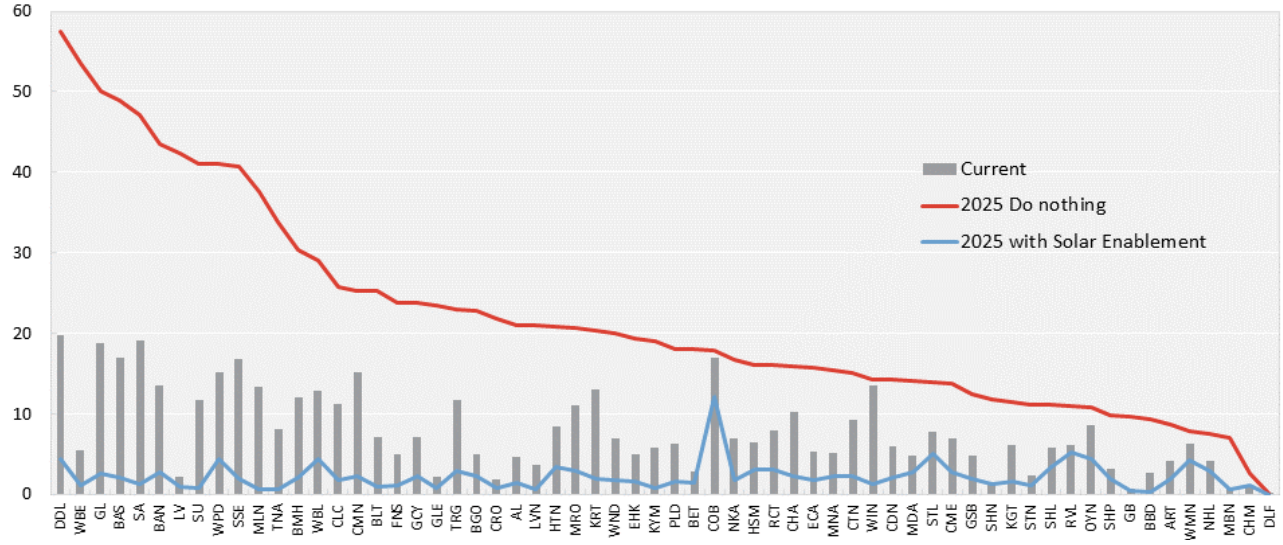
Similarly, SA Power Networks have noted that their ability to ask for demand management services from the market is hampered as it is dependent on being able to access granular, real time information.[5] By extending the sophistication of our demand management programs, we can deliver further benefits to customers.

Customer uptake of solar

Solar penetration will continue to increase driven by government subsidies and the declining cost of rooftop solar. We have therefore developed our Solar Enablement program, which involves using both network and non-network solutions to facilitate customers' uptake of solar in a cost-efficient approach. By undertaking planned and targeted investment under Solar Enablement, we'll unlock over 95% of the solar that would otherwise be constrained while maintaining affordability. The figure below shows the percentage of time solar is constrained due to high voltages now, in 2025 if we do nothing and in 2025 after this Solar Enablement program for each zone substation on our network.

5 SA Power Networks, 2020-2025 Draft Plan: Delivering better outcomes at a lower price, (2018), p 31 (PAL ATT198).

Figure 6 Time (%) of solar constrained due to high voltage under three scenarios



Source: Powercor, Enabling residential rooftop solar business case. For CitiPower see its associated business case.

Nevertheless, this project determined that it will be cost prohibitive to allow all customers to export their solar at all times. Our Digital Network will allow us to support these customers by assisting them to optimise self-consumption of their solar.

2.1.4 HV-level initiative complimentary to Digital Network

In addition to our demand management and Solar Enablement programs, we are also developing a longer term complimentary program to Digital Network in order to manage emerging constraints on the HV network resulting from high DER penetration.

Case study: Managing constraints on the HV network as a distribution system operator

We are implementing new capabilities to manage higher DER penetration and the resulting network constraints on the HV network provide us the potential capability to operate as a distribution system operator (**DSO**).

In alignment with the Open Energy Networks framework, we have set up a DER register to manage DER connections and associated metadata. We have also engaged a technical consultancy to help us explore how we can control supply and demand on the HV network and transition into a DSO over the next 10 years.

We intend to implement a distributed energy resources management system on our HV network, and updating customer contracts to enable dynamic constraint application. Future benefits would include managing operational risk and allowing increased generation depending on dynamic network parameters. This program is the subject of an upcoming demand management innovation allowance application.

2.1.5 Grid of the Future review by the Australian Energy Market Commission (AEMC)

In its latest annual Grid of the Future review, the AEMC noted that in future consumers will buy, trade, sell and store electricity and participate in new service markets such as demand response.

They further noted that:

> *"As consumers' interactions with the electricity system evolve, so will their expectations and required standard of service … the electricity system (especially at the distribution level) is increasingly likely to*

have multi-directional flows and become a platform to support different services, such as access to various markets, that future electricity system users may demand. The future electricity system and the regulatory framework need to be able to support these and potentially many other varieties of use."[6]

A Digital Network is a fundamental element in supporting this energy future.

2.1.6 Other distributors' approaches to managing future network challenges

Overseas jurisdictions, particularly in the United States of America (**USA**), are also progressing their own versions of the initiatives we are proposing through our Digital Network and Solar Enablement programs (See our Enabling Residential Rooftop Solar business cases). In addition, the USA's Federal Department of Energy has established a Grid Modernisation Initiative to help develop the 'grid of the future'.[7]

Reflecting a mix of network and non-network technological solutions, these projects are considering how best to facilitate the uptake of solar, support customer uptake of electric vehicles and batteries, optimise the use of customer appliances by shifting usage from peak periods as well as developing new demand management programs and tariffs.

Figure 7 Overseas digital network and solar developments

New York	As part of regulating for 50% renewable energy by 2030, New York has created *Reforming the Energy Vision* (**REV**) as the State's strategy to build a clean, resilient, and affordable energy system. The State is introducing smart grid technology to help manage and promote DER, communicate with electric vehicles and introduce combined heat and power system. This technology will also improve the efficiency, quality and reliably of network operations, as well as to lower operating costs
Hawaii	Hawaii has legislated for a 100% renewable portfolio standard target by 2045. Hawaiian Electric Industries provides 95% of the State's residents. They have begun implementing their strategy, publishing a roadmap for a more resilient and renewable-ready network as an estimated cost of USD$205M over 6 years. Activities include introducing new technology to triple the amount of rooftop solar on the network, predict and avoid outages, and incorporate sophisticated demand response initiatives.
Rhode Island	A Rhode Island utility, National Grid, has also begun modernising its network. It has a number of initiatives in the pipeline including DER optimisation, control DER power flows, launch electric vehicle and storage programs, DER exports, roll out demand response and introduce new types of tariffs. A key enabler to these initiatives is to implement AMI meters.
United Kingdom	A United Kingdom (UK) analysis of electricity flexibility options found that the UK could save £17-40 bn across the electricity system between 2016 to 2050 when comparing electricity systems that do and do not deploy additional flexibility technologies. This includes using technologies such as demand response, storage and interconnectors to reduce the need for carbon intensive generation, balancing the network at lower cost, improving the utilisation of existing generation and deferring the need for network augmentation.

Source: Powercor

In addition, see Appendix A for a summary of the approaches of other Australian distributors to implement intelligent networks.

6 Australian Energy Market Commission, Electricity network economic regulatory framework review 2019: Integrating Distributed Energy Resources for the Grid of the Future (26 September 2019) (PAL ATT206).

7 Department of Energy, Grid Modernization Initiative (accessed 10 October 2018) < www.energy.gov/grid-modernization-initiative>.

3 Identified need

3.1 Ensuring sufficiency of technological capabilities

We need to invest in new technological capabilities to ensure we continue to provide the services are seeking at the lowest cost.

Therefore during the 2021-26 regulatory period, we will improve the ways we combine and generate real-time, actionable insights from our data through analytics and implement more sophisticated monitoring and management capabilities so that we can run the LV network dynamically.

This involves implementing the technological capabilities outlined below. A detailed description of the proposed technological solution and a roadmap for implementation developed with support from Litmus consultancy is provided in Appendix C. Note our approach to rolling out network devices are discussed in the following section.

Table 4 Overview of Digital Network technological capabilities, $m 2021

Area	Capability	Cost
Data	Real-Time Data Platform	2.1
	IoT Platform for Network Sensors	5.1
	IoT Platform for Customer Sensors	1.2
	LV Model Extension	3.2
Analytics	Real-Time Grid Analytics Platform	2.1
	Real-Time LV Power Flow Analysis	1.1
Monitoring	Real-Time Grid Monitoring and Control	2.2
	LV Management Capability	1.0
	Dynamic Forecasting Capability	1.1
	DER - Monitoring Capability	1.1
Automation	DER - Automation	1.1

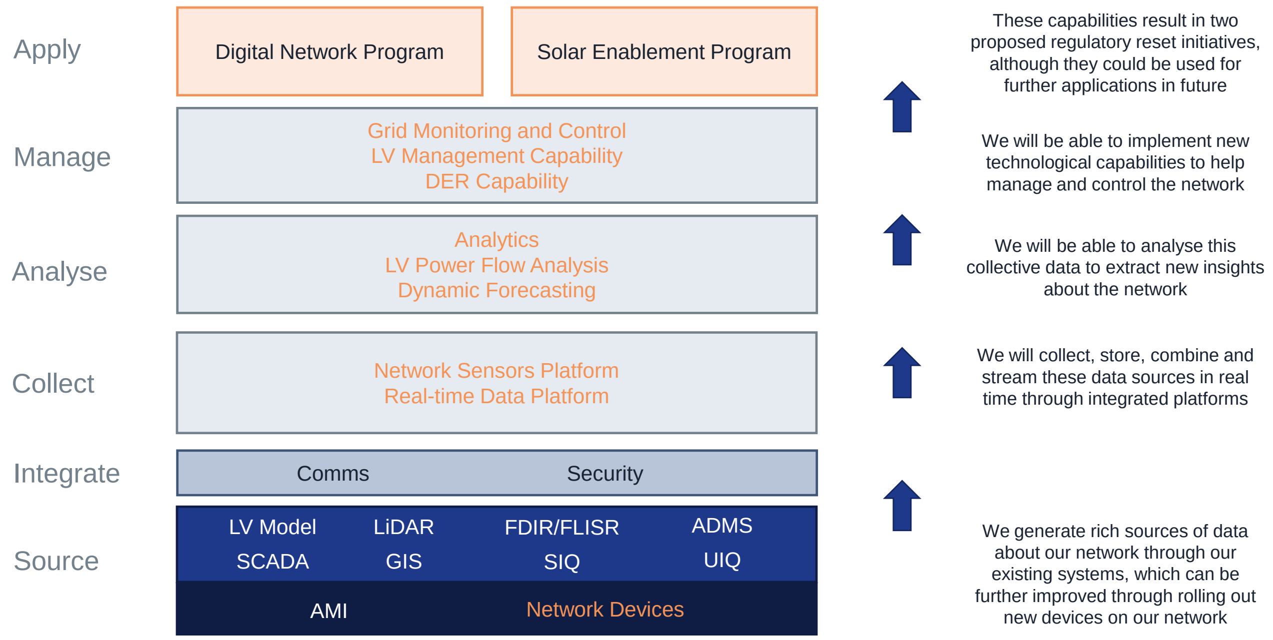
Source: Powercor

As seen in the diagram below, we can apply these capabilities and realise programs of work like Digital Network as follows:

- **source**: the originating source of data about various aspects of our network
- **integrate**: this layer integrates source systems with platforms
- **collect**: data streams captured in source systems are consolidated and streamed in real time through integrated platforms
- **analyse**: data assembled in the platforms are analysed so we can extract real-time, actionable insights about the data
- **manage**: new technological capabilities will allow us to manage and control the network

- **apply**: through these technological capabilities we can develop new programs of work, such as our Digital Network initiatives.

Figure 8 The Digital Network framework



Note: orange symbolises new or enhanced capabilities

Extending our AMI-underpinned initiatives via Digital Network technologies is part of a long term vision for our network. Over the 2021-2026 regulatory period, we will focus on building our existing capabilities to enhance LV network visibility and our ability to monitor the network. We will also begin implementing some network management capabilities towards the end of the period. Further in future, we intend to implement more sophisticated, automated capabilities. See the Roadmap in Appendix D.

By taking advantage of new technology, we can deliver benefits to customers through deferring augmentation, enabling new customer tariffs and maintaining reliability in the face of more load volatility on the LV network. Digital Network will allow us to move from manual to automated processes, further lower network costs, provide visibility of the LV network and enhance our service offering.

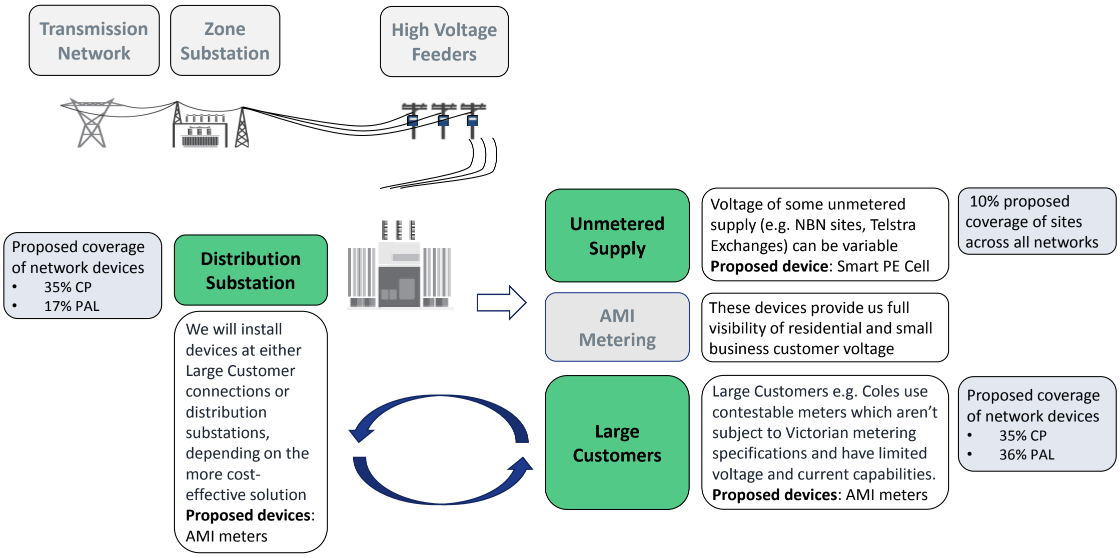
3.2 Extending our device coverage beyond AMI

While we have visibility of our residential and small business customers through AMI, we do not have the same visibility of other parts of the network in areas where AMI has not been rolled out, such as our large customers or unmetered supplies.

While the impact so far has been manageable, over time network management will become more challenging as new innovations affecting the LV network such as solar, electric vehicles and batteries, become more prevalent. By rolling out devices to improve our LV network visibility, we can further improve safety, defer capital expenditure, enable better demand management, provide supply compliance and reduce customer complaints.

We have developed a targeted approach to roll out further network devices to large customers and unmetered supplies through analysing different scenarios. This optimisation approach allowed us to halve the number of network devices we will need to install. See Appendix B for more information on this approach.

Figure 9 LV visibility improved by targeted rollout of network devices either at customer or distribution transformer level



Source: Powercor

Note: green areas will benefit from network visibility. Proposed coverage is devices as a percentage of total number of assets of that particular asset class.

3.3 Initiatives and resulting benefits

Digital Network builds on, and creates new, initiatives to enhance the effectiveness of our safety programs and our operation of the network benefiting customers.

We commissioned Jacobs to quantify the benefits of three different implementation options aimed at maximising benefit to customers. The diagram below displays the options, which build cumulatively on each other. For the rollout of devices under option 2, we conducted an internal sensitivity analysis of the optimal device coverage, which is described in Appendix B.

Figure 10 Options analysis

Options	Options description	NPV 2021-2041
0. Baseline	Continue utilising AMI data through existing technology and receive base level of benefits	NA
1. Digital Network Technology	Invest in new technology that provides greater network monitoring and control capabilities	$104m
2. Technology and targeted rollout of network devices	Increase the current coverage of network devices in a targeted approach to improve LV visibility in addition to option 1 technological capabilities	$141m

Source: Powercor

See the Jacobs Digital Network Report for detailed information on the benefit approach.[8] Their methodology involved using a mix of internal data and external data (eg. AEMO). Given the absence of certainty in terms of

[8] PAL ATT009 - Jacobs - Digital Network benefits - Dec19 - Public.

take-up of new technologies, different sensitivities were explored (eg. how electric vehicle uptake will occur), with more conservative forecasts adopted in the final analysis.

Table 5 Overview of Digital Network benefit streams, $m 2021

Initiative	Description	Benefits of option 1 2021-2041	Benefits of option 2 2021-2041
1. Promoting electric vehicle uptake	Monitor electric vehicles charging to understand and estimate the impact of increasing demand on the distribution network. This can be optimised by shifting demand from peak periods so that costs remain low for all customers. This includes designing tariffs to encourage charging at non-peak periods, which may include times of excess solar. Ultimately this will support customers' uptake of electric vehicles while delaying augmentation so that customers' energy bills remain low.	46.1	79.8
2. Optimise load control of customer appliances	Optimise existing hot water load control and enable new load control programs (eg. air conditioners and pool pumps) on an opt-in basis by shifting loads to periods of low demand, which may be when there is excess solar. This will allow usage occurred outside of peak demand periods, ultimately reducing augmentation and lowering customer bills.	79.1	81.5
3. Enhance cost reflective pricing	Extract more insights about load and customer behaviour and better identify network constraints (eg. highly utilised transformers). This data will assist us to develop more effective tariffs and voluntary demand management programs and extend their coverage. This in turn will defer augmentation and increase customer participation in new programs.	10.6	14.3
4. Detect electricity theft	Expand our AMI data and analytics capabilities and install more network devices to more accurately detect and reduce electricity theft (by up to 50%) and more accurately record unmetered supply. This will reduce customer bills by ensuring a fair allocation of energy used, and increase safety by deterring theft (which is carried out by circumventing meters).	3.6	9.5
5. Proactively managing asset failures	Through enhancing network data (of voltage, loads and assets) we can improve the way we monitor and predict network asset failures, including of connection assets (eg. service mains) and distribution transformers. This will allow us to defer augmentation, avoid replacement expenditure and maintain reliability.	Unquantified	Unquantified
6. Avoiding overblown fuses	Use network data to better assess and balance the loads connected to each phase of distribution transformer, preventing blown fuses. This will defer augmentation, avoid replacement and maintain reliability despite increasing volatility as solar and electric vehicle uptake increases.		
7. Looking after vulnerable customers	Expand our AMI data and analytics capabilities to improve the way we identify which phases customers are assigned to, which is particularly important to safeguarding the wellbeing of life support customers.		

8. Keeping customers safe	Our existing meter insights algorithm identifies potential loss of neutral at our AMI customers' homes, which can pose major safety issues of electric shocks if left unchecked. Through enhancing our AMI data, the effectiveness of this program can be improved and extended to new customers.

Source: Powercor

The first four quantified benefit streams are discussed in the section below with unquantified benefits following.

Table 5 below outlines the specific Digital Network technologies required to enable each initiative.

Table 6 Digital Network initiatives – platform matrix

	Real-time data platform	IoT platform for network sensors	IoT platform extension customer sensors	Real-time grid analytics platform	Real-time LV power flow analysis	LV model extension	Real-time grid monitoring and control	LV management capability	Dynamic forecasting capability
1	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓				✓
4	✓	✓	✓						

Source: Powercor
Legend: 1 - Electric vehicle charging , optimisation; 2 - Customer load monitoring and optimisation; 3 - Accurate & dynamic cost reflective pricing; 4 - Reduction of non-technical losses

3.3.1 Quantified Digital Network benefits

Electric vehicle charging optimisation

Forecasts for electric vehicles show significant growth over the next 20 years and this is likely to have a large impact on energy consumption and maximum demand.[9] Charging patterns for electric vehicles include night and daytime charging at home, around commercial zones and buildings as well as at public charging facilities. However, it is expected that a significant part of electric vehicles charging will be of the 'convenience' kind, when consumers come home after work and plug-in their electric vehicles, coinciding with peak periods. During these periods electric vehicles charging is likely to substantially increase maximum demand.

As discussed in section 2.1 above, without action in the current period, electric vehicle charging will place pressure on network operations. Given the long lead times to implement the more sophisticated capabilities needed to manage electric vehicle uptake, we need to invest now before electric vehicle charging becomes a large problem that results in more inefficient solutions (as we are experiencing with the uptake of roof top solar).

Digital Network will allow us to monitor the impact of electric vehicles and to estimate the impact of increasing demand on the network. Accordingly, we will be able to coordinate charging with excess solar and time-of-use

9 Electric vehicle penetration forecast based on AEMO ISP 2019 Input and Assumptions workbook (PAL ATT167).

tariffs, ensuring charging stations are at low currents in order to reduce the impact of electric vehicles on demand[10] and target measures based on local constraints.[11]

Benefits

The quantified benefit derives from deferred augmentation through limiting the impact of electric vehicles charging at peak periods. Other, unquantified benefits include to facilitate customer choices while improving asset risk management and supporting environmentally-friendly vehicles.

2. Optimise load control of customer appliances

Household appliances like air-conditioners, pool pumps and electric hot water systems can increase maximum demand when not optimised during peak hours. Air-conditioners are generally the largest contributors to the evening peak and are still growing in volume and size.

Through Digital Network, we can manage the loads of these types of appliances more dynamically to off-peak periods by using more accurate forecasting and planning to effectively respond to weather conditions. So while hot water systems have traditionally been switched on during the night, these can be optimised and switched on during times of lower usage, which may include during times of excess solar such as in the middle of the day. Similarly, through Digital Network we could identify which customers were typically higher users during peak periods and approach them to participate in load optimisation to reduce peak demand.

In addition, the initiative can provide the foundation for voluntary load optimisation participation through aggregators and/or retailers, as it can prevent duplication of Digital Network Infrastructure costs (e.g. platforms, communications, security, data repositories).

Benefits

The main benefits are in the short term direct bill reductions for consumers (optimisation of their load devices to time-of-use tariffs) and in the long-term deferral of augmentation expenditures, resulting from optimised utilisation of the network and reduction of peak demand.

Also, wider consumer and market benefits may be accomplished (e.g. generation cost reductions) by facilitation for aggregators and retailers to voluntary load control applications in the market.

The main benefits result from direct bill reductions to consumers (i.e. through optimisation of their load devices with solar capacity) and for the long-term deferral of augmentation expenditures, resulting from optimised utilisation of the network and reduction of peak demand.

3. Enhance cost reflective pricing

Cost reflective pricing can be implemented in various ways, either by discouraging the use of electricity during peak times through higher tariffs (eg. time of use tariffs) or by providing rebates to customers who reduce their consumption at peak times or shift their consumption away from peak time, such as through demand management programs (eg. Powercor’s energy partners program). However, current tariffs are mostly determined and implemented statically.

Digital Network technologies will allow us to analyse real-time AMI interval data and identify how load flows change with customer behaviour to provide more insights into customers’ loads and their corresponding

10 Charging pile selections maximise the number of electric vehicles that can be plugged in at the same time.

11 For example, we could target specific streets, suburbs or customers connected to a specific transformer to change their electric vehicle charging patterns to reduce the impact on the local LV network.

behaviour. This will allow us in turn to construct more targeted, effective cost reflective network pricing reducing peak demand and improving utilisation of the network. Digital Network will also allow us to increase the coverage of these programs through greater technological monitoring and management capabilities and to extend these programs more effectively to new customers.[1]

Benefits

The benefit stems from reduced customer bills through augmentation deferral. This arises through more effective tariff structures reducing peak demand on the local network. There are also direct benefits for customers enrolled in demand management schemes who could be eligible for rebates.

These benefits can be significant. The current Summer Saver program being operated by United Energy (which CitiPower and Powercor are similarly rolling out) has been able to defer $8m of augmentation in 2017/2018 through demand reduction in areas close to their capacity limits. These savings are increasing over time the longer the project has been rolled out. As CitiPower and Powercor's combined network is larger than United Energy, it is expected that the benefit could be larger and has been pro-rated up to $12m per annum. This is a rolling amount that continues to be saved for each year the program is operational.

The value of the program can be further extended through the inclusion of winter peak programs, becoming more relevant in future years when winter peak demand is expected to grow faster than summer peak demand in the next decade.

4. Detecting electricity theft

Non-technical losses in the network refer to those losses not attributable to the transportation of electricity (i.e. technical losses). This can occur due to:

- inaccurate measuring instruments
- electricity usage based on estimations rather than measuring instruments
- illegal usage of electricity by tapping into service connections before the installed metering device (i.e. electricity theft).

This has adverse safety implications and increases customers' bills via unrecovered energy usage.

Utilising Digital Network technology alongside our AMI data will allow us to more precisely monitor network usage and to detect electricity theft and other unallocated network losses. By rolling out network devices (e.g. to large customers and unmetered supply), we can further enhance this customer benefit, by gaining greater visibility of customer usage.

Additional benefits include safety as electricity theft is done by circumventing the electricity meter which creates significant hazards such as risk of electrocution or fire.

Benefits

The benefits have been split into two quantified benefits below:

11. **Reduction in theft**: Digital Network will allow us to further reduce remaining theft by between 25-50%, with the upper range being realised by increasing the coverage of network devices.
12. **Reduction in under-recording of unmetered supplies**: additional devices for unmetered supplies will allow better identification and accuracy of these loads. It is estimated under-recording unmetered supplies could be reduced further by 20-50%.
13. Although there are safety benefits, they have not been quantified.

3.3.2 Unquantified Digital Network benefits

Four additional benefit categories that have not been quantified due to a lack of data or certainty of outcomes are outlined below.

5. Proactively managing asset failures

Voltage and current data is being used to inform an LV model (foundation of Digital Network framework) that can accurately monitor impedance changes for supply points and predict if failures are likely to occur. When actioning points of failure in a timely way, the number of fire-starts in the LV network, or any catastrophic events resulting from these fire-starts can be reduced.

Digital Network can improve our prediction abilities by incorporating more voltage and current data into our analysis. By actioning points of failure more quickly, the number of fire-starts in the LV network, or any catastrophic events resulting from these fire-starts can be reduced.

By installing sensors (e.g. oil level measuring) and network devices on critical distribution assets, in conjunction with analytics, we can monitor asset conditions and take action to prevent failures, outages and/or prolong asset lives.

This initiative can generate benefits for customers through preventing failures, reducing associated outages and/or safety issues related to these failures (eg. explosions of transformers, oil leaks). It may also save costs on inspections for those assets that are remotely monitored.

Additional benefits include better risk management and replacement prioritisation that can defer replacement expenditures.

6. Avoiding overloaded fuses

Using HV and AMI data, we can use LV phase identification to assess the loads connected to each phase at the distribution transformer through data science techniques to estimate which customers are connected to each phase. Implementing an enhanced LV model and network data under Digital Network will allow us to confidently identify more customers connected to each phase and alleviate overloading through redistributing loads to the more lightly loaded phases. This process reduces the risk of faults at the distribution transformer level, reducing overall restoration times for customers and corrective maintenance call-outs, avoid replacement expenditures and increase asset utilisation leading to deferred augmentation.

7. Looking after vulnerable customers

Our current ability to identify customers on particular phases is based on estimates using AMI meters. Through Digital Network technology, we can improve the way we identify particular customers/loads on each phase. This will support more accurate notifications of customers for planned outages, in particular of importance to the safety of life support customers. Cross referencing life support customers to distribution transformers will ensure these customers are notified.

Coverage and accuracy can be improved by installing more network sensors on distribution transformers and contestable/unmetered sites. This would create greater accuracy through LV mapping providing overall benefits to the LV network model. This initiative will also benefit from updates to our Geospatial Information System.

8. Keeping customers safe

Our existing meter insights algorithm identifies potential loss of neutral at our AMI customers’ homes, which can pose major safety issues such as electric shocks if left unchecked.

Through enhancing our AMI data and our coverage of network devices, the effectiveness of this program can be improved and extended to new customers.

3.3.3 Sharing data with stakeholders

Our stakeholders have told us they want access to the network data that Digital Network will support.

This is also reflected in the AEMC's Grid of the Future review, which discussed the need to provide information to support customer decision making. This includes making information available assist customers make informed decisions around whether and what types of solar technologies to invest in, and to allow existing users to understand when and how to use their solar. Information could include voltage data, DER register data, smart meter data, customer data right data and inverter data.

To facilitate data sharing, we will be further consulting with stakeholders on their data needs so we can determine the best and most cost efficient way of providing data to them in the future. Initiatives described in our Customer Enablement business case will also enhance data sharing with customers over 2021-2026.

3.3.4 Interaction between Digital Network and augmentation program

Some level of network augmentation will always be required due to factors such as population growth and increases in per capita energy usage (as people uptake more household devices or purchase EVs for example).

In addition to the quantified benefits discussed above, Digital Network will also decrease network costs by improving our supply quality management works. It will do this by allowing us to more effectively determine and target which assets need replacing or upgrading and which can instead undergo demand management to alleviate network constrains. This will prevent the costs of these works escalating in the future. This has been factored into our existing forecasts. See our Augmentation Chapter for further information about how Digital Network interacts with these proposed works.

3.4 Recommended option

Results for all options are included in table 5, which includes the present value (**PV**) of costs and benefits, the net present value (**NPV**), and the internal rate of return for option 1 and 2. Option 2 has a higher NPV and a strong internal rate of return (**IRR**), demonstrating that the cost of implementing this option is significantly outweighed by the benefits customers will receive.

Table 7 Results for options 1 and 2 for 2021-2024, $m 2021 (excluding operating expenditure)

	Option 1	Option2
PV value of costs	35	44
PV value of benefits	139	185
NPV of costs and benefits at 2.75% real WACC	104	141
Benefit-cost ratio (NPV)	3.95	4.21
Internal Rate of Return	28.7%	30.6%

Note: includes capital expenditure only
Source: Jacobs, Cost Benefit Analysis for Digital Network Implementation (PAL MOD 7.13)

By taking advantage of new technology under option 2, we can deliver benefits lower network charges through deferred augmentation and innovative network tariffs whilst at the same time maintaining reliability in the face of more challenging voltage and load conditions on the LV network.

The table below specifies our proposed investment over the 2021-2026 regulatory period. While this project also incurs operating expenditure, we propose to absorb these costs, given the importance of this project.[12]

Table 8 Recommended options 2 investment profile for 2021-2026, $m 2021

Network	Cost component	2021/22	2022/23	2023/24	2024/25	2025/26	Total
CitiPower	IT[1]	$2.8	$3.2	$3.1	$0.9	$1.2	$11.1
	Augmentation[2]	$1.1	$1.1	$1.1	$1.1	$1.1	$5.5
Powercor	IT[1]	$2.8	$3.2	$3.1	$0.9	$1.2	$11.1
	Augmentation[2]	$0.9	$0.9	$0.9	$0.9	$0.9	$4.7
Total		**$7.6**	**$8.4**	**$8.2**	**$3.8**	**$4.4**	**$32.4**

1.This involves the technology costs, as found in PAL MOD 7.01 - IT capex - Jan2020 – Public and CP MOD 7.01 - IT capex - Jan2020 - Public
2.This involves the network device cosst, as found in PAL MOD 6.04 – Network comms – Jan2020 – Public and CP MOD 6.04 – Network comms – Jan2020 – Public
Note: numbers may not reconcile due to rounding; includes capital expenditure only.
Source: See footnotes 1 and 2 above.

12 This operating expenditure is still included in Jacobs cost-benefit analysis (see attachment PAL MOD 7.13 - Digital network Jacobs benefit - Jan2020 - Public) to ensure that the business case is valuable to customers over the long term.

A Approaches of other Australian distributors

The below figure provides a summary of the approaches of other Australian distributors.

Figure 11 Intelligent network developments of other Australian distributors

SA Power Networks	SAPN is proposing a Future Network Strategy to transition their network to support the shift to a low-carbon, decentralised energy system and at the same time maximise value for customers. The strategy seeks to improve visibility on LV network, implement a DER register to map out how and where these are installed and establish systems to communicate with small customer systems and aggregators. They have proposed 32 million capex over the 2020–2025 period. These initiatives will also include complementary measures to increase network hosting capacity such as shifting hot water loads during daytime and substation voltage control which will require more investment in gain greater visibility on LV network.
AusNet services	AusNet is seeking new ways to support the new energy solutions being sought by customers (e.g. solar panels, batteries). They are holding consultations with customers forums to explore new approaches. These approaches aim to improve management of the effects of solar uptake on the low and high voltage network, trial Stand Alone Power Systems in remote parts of the network to improve reliability as well as enhancing data availability to support customer choice and decision-making to promote non-network solutions. One of these initiatives is the GoodGrid Program, which aims to reward selected customers that are willing to manage differently their energy use during high
energex	Energex, is exploring new ways to support the increase demand from customers to use alternative energy solutions that give them more control over their usage (solar panels, batteries). They are implementing intelligent grid to assist in integrating new measures (solar, batteries, electric vehicles, etc.) in a cost effective and sustainable wag through a Future Network Strategy – Roadmap to an Intelligent Grid. During the regulatory period 2020–2025 they will also continue to support load control as a tool to manage network demand, such as controlled EV charging in coordination with local network constrains and price signals
Ausgrid	Ausgrid intends to invest $58 million in innovations project and $41 million in an Advance Distribution Management System (**ADMS**), these investments will help optimise orchestrated demand management solutions such as support customers to enable smart control of batteries and appliance. During 2020-2024 regulatory period, Ausgrid will also explore new ways to operate the network more efficiently. These initiatives include: peak time rebates – using smart meters and other energy monitoring systems to allow customers to shift their energy usage Ausgrid's CoolSaver program – selected customers will receive incentives to reduce peak electricity demand from their air conditioner using the in-built power saving modes of modern air conditioners
Endeavour Energy	Endeavour Energy will adopt battery trials to identify their benefits and potential impact during the regulatory period 2020 – 2024. They forecast that the full implementation of these technologies will be slow but it will allow customers to be more in control of their usage. They will also implement new capabilities at the network and non-network level to support these market changes. This includes to accurately forecast maximum demand in advance, to help network planning as well as to efficiently review demand management and other non-network solutions to subdue network demand at these peak times. These solutions will include battery storage trials and programs to reduce demand and/or defer investment (e.g. peak shaving, load shifting and broad-

Source: Powercor

B Scenario analysis of Network devices rollout

B.1 Locations of network device installations

Below we discuss three areas on our network that do not provide us with the same visibility as our AMI metered customers, namely Type 1-4 contestable metered customers (**Large Customers**), unmetered supplies (**UMS**), and distribution transformers.

B.1.1 Type 1-4 contestable meters

There are about 6,500 and 7,000 Type 1-4 contestable metering sites (i.e. large customers that consume more than 160MWh per annum) in CitiPower and Powercor, including single phase contestable metered sites, three phase contestable metered sites, LV CT connected contestable metered sites and HV CT connected contestable metered sites.

These sites are metered by contestable metering providers using Type 1-4 meters. However, access to real-time consumption and power quality information is not available, given that these sites do not have AMI meter functionality. These sites are therefore invisible.

Interaction between Type 1-4 contestable meters and distribution transformers

To improve visibility we can either deploy monitoring devices at these customer connections or on distribution transformers according to the more economically efficient option. More specifically:

- Where a single contestable metered customer exists, it is more economic to install a network device at the customers premise rather than at the distribution transformers. This is because a meter board and LV metering current transformers already exist in the metering installation, which decreases installation time and equipment. Overhead lines have a higher risk of safety issues, so installing network devices on customers with overhead lines is prioritised.
- Where there are two of more contestable metered customers, overall installation becomes more cost effective at the distribution transformer. This also provides an alternative in cases where there is not sufficient space to fit the network device to the customer site or access is denied by the Metering Coordinator. This will allow us to identify the entire LV network. However, this won't provide the same level of visibility as placing network devices on 100% of the large >160MWh LV customers.
- In addition, for large multiple occupancy sites such as shopping centres (which can have a number of large contestable connected metered supermarkets, department stores or connected metered specialty shops) and high rise commercial and residential buildings, it is more prudent and cost-efficient to monitor the entire load and point of supply than monitoring at the metering installation given we do not have supply responsibility for these customers.

B.1.2 Unmetered supply

There are 8,500 and 10,100 franchise un-metered supplies in CitiPower and Powercor that are also invisible. Although these are small loads in the order of 2 to 6 Amps, some unmetered supply can have greater voltage variability. There is significant growth in the un-metered supply connections related to growth in the use of telecommunications equipment, and they, along with other essential services such as traffic lights, require better management of outage and voltage level monitoring to deliver the expected reliability of these societal services.

Under the targeted rollout, network devices will be installed on 10% of available sites, which will allow their current profiles to be better modelled to improve the accuracy of our network monitoring.

B.2 Sensitivity analysis

We considered three options to determine the lowest cost approach to rolling out devices on the network while ensuring sufficient visibility.

These options are:

- **Option 1 – Targeted monitoring**: install network devices on selected contestable metered large customers sites, unmetered supplies, and at the distribution transformer level of 300kVA or greater capacity, with 2 or more contestable metered large customers connected to them to provide sufficient network visibility cost-efficiently.
- Given the information in Section C.1 above, the targeted rollout of devices at contestable customer sites will occur in the following circumstances:
  - the contestable metered customer has an overhead service supply, or
  - those customers are a three phase or LV current transformer (**CT**) connected customer on a distribution transformer with only one contestable customer, or
  - the distribution transformers is less than 300kVA in size
  - in other cases, devices are instead rolled out at the distribution transformer.
- **Option 2 – Full customer monitoring**: install network devices on all contestable metered large customers, and un-metered supplies, with no network devices deployed on distribution transformers.
- **Option 3 – Full 300kVA+ distribution transformer monitoring**: install network devices on all distribution transformers with one or more contestable customer connected with network devices only deployed on 10% of the low voltage contestable metered large customers and un-metered supplies.
- This results in the deployment of network devices as seen in the table below.

Table 8 Deployment of network devices

Location	Description	Coverage
Distribution transformers	Distribution transformers (300kVA or greater capacity), with 2 or more contestable metered large customers connected to them, including large, multiple occupancy sites	35% CP, 17% PAL,
Single phase sites	Single phase contestable metered sites (small <160MWh loads), supplied with overhead services not located in shopping centres. This includes a small number of residential customers and a larger number of small commercial customers	10%
Three phase sites	Three phase contestable metered sites (large >160MWh loads) located across smaller distribution transformers with overhead services. These are commercial customers, who are typically connected via street circuits in shopping strips with overhead services	50%
LV CT sites	LV CT connected contestable metered sites (very large >160MWh loads). This involves commercial customers often with an on-site distribution transformer.	30%
HV CT sites	HV CT connected contestable metered sites (largest >160MWh loads) for industrial customers.	100%

Source: Powercor

The proposed rollout aims to maximise network visibility by targeting our largest customers contributing the most invisible loads or those customers with overhead services who represent higher safety risks.

These sites will be monitored for voltage regulation, coincident current demand and supply quality including power outage notifications. Customers with Type 1-3 meters will also be monitored and their respective loads aggregated to determine LV phase balance and LV feeder loadings as well as for their contribution to distribution transformer total co-incident load.

Recommendation

Ultimately option 1 targeted monitoring was found to be the most cost-efficient option through strategically rolling out network devices to selected contestable meters, un-metered supplies, and distribution transformer sites, in order to deliver customer benefits through a safer and better managed network.

Table 9 CitiPower-Powercor devices summary of results of devices analysis

Option	Total volumes	Total cost ($m 2021)
Option 1 (Do nothing)	0	$0.0
Option 2 (Targeted monitoring) - *Preferred*	8,188	$10.1
Option 3 (Full customer monitoring)	22,935	$16.7
Option 4 (Full 300kVA+ transformer monitoring)	11,229	$23.6

Source: Powercor

C Digital Network Initiatives

Table 9 Detailed description of initiatives

Initiative name	Initiative description
Real-time data platform	New data sets are being generated from more systems in more frequent intervals (i.e. real time) than ever before. This initiative aims to modernise our existing data platforms to enable the collection, consolidation, processing and streaming of these growing data sets. The new platform will in turn provide a common infrastructure from which to apply analytics to generate new insights about our network and customers and create more advanced management capabilities. This includes for example integration between smart meter data and other real-time systems such as SCADA to enable more sophisticated automated voltage management or integration between EV charging stations and the grid. Sources of real-time integrated data feeds include from devices (e.g. network devices, IoT devices, any other customer devices), real-time systems (e.g. Demand Response Systems, Distributed Energy Resource Management Systems, SCADA, OMS, DMS etc.), corporate systems (e.g. Customer Information System, Asset Management Systems, Workforce Management) and external feeds (e.g. Emergency Services, weather feeds etc.). The components included in this initiative are: common data lake platform, real-time unified data streaming, real-time unified data space, distributed bus capable of managing signals from all connected devices on the network, security capability, and necessary augmentation to the communications network to manage increased frequency in data collection.
IoT platform for network sensors	This initiative aims to provide a platform to collect data from network devices and network sensors in order to increase real-time visibility of the network, asset data and condition through digitalised versions of asset and network configurations. The components included in this initiative are: IoT management platform for network platforms and sensors, security capability, and digital twins for IoT applications. The digital twins will be used to analyse and simulate real world conditions, respond to changes and improve operations based on the data provided by the sensors in the physical world. The IoT platform implemented in this initiative will be extendable to service customer sensors, discussed below.
IoT platform extension for customer sensors	This initiative aims to expand our relationships with customer (e.g. consumers/prosumers) by extending network visibility and management through integration with customer side innovations that sit outside of centralised functions (e.g. electric vehicles, load control). By having the ability to control devices as approved by the customers, we will be able to optimise the use customer side DER/DG to manage peak demand as well as return the value to the customers, e.g. control over customer's solar PV inverter. Relevant case studies such as Eddy Home Energy App (**CSIRO**) and Hot Water Load Control Trials (**Ausgrid**) showed that customers are receptive of having their loads controlled by a third party and the uptake of residential load control systems are higher if the schemes are incentivised. The components included in this initiative are: extension of the IoT platform for network sensors to enable integration with customer devices and other external IoT platforms, security capability and effort required for integration including digital twin.

Real-time grid analytics platform	This initiative aims to modernise the existing grid analytics platform to enable open and scalable real-time data analysis using streams of data from multiple sources (see real time data platform above) to analyse trends, patterns and events in real time. The modernisation is required to deal with the increased volume and speed of data being generated from IoT sensors and customer devices/sensors and to address new use cases. The platform alongside IoT platform will enable real-time management ability. The components included in this initiative are: modernisation of real-time grid analytics platform, visualisation capability (e.g. asset data visualisation), integration and security.
Real-time LV power flow analysis	This initiative aims to improve the existing create more visibility of the LV network by capture more accurate information on LV model, phasing and customer connectivity. Integrity of LV model is required as the model is the baseline for real-time network monitoring and control, advanced distribution management, and subsequent network automation. The components included in this initiative include: extension of the current grid analytics platform to identify discrepancies in LV model using AMI and faults data, and process to accurately collecting changes in the field and documenting the changes/updates in the model. The Power Quality Data Collection initiative will enable this initiative to be delivered efficiently using higher frequency power quality data.
LV model extension	This initiative aims to enhance our existing LV model to create more visibility of the LV network by capturing more accurate information on phasing and customer connectivity. Integrity of LV model is required as the model is the basis for a number of capabilities including real-time network monitoring, advanced distribution management, and subsequent network automation. The components included in this initiative include: extension of the current grid analytics platform to identify discrepancies in LV model using AMI and faults data, and process to accurately collecting changes in the field and documenting the changes/updates in the model. The Power Quality Data Collection initiative will support this initiative efficiently using higher frequency power quality data.
LV management capability	This initiative aims to extend the current capabilities enabled by ADMS and Real-Time Grid Analytics Platform to integrate decentralised energy (e.g. DER) into the HV and LV network. Some applications of this capability include protection for reverse flow management, control to support electric vehicles charging system to manage charging demand, and control of embedded grids. The components included in this initiative are: dashboard, integration, mobile capability and security capability to enable distributed control/edge intelligence.
Real-time grid monitoring and control	This initiative aims to create flexible LV control which will allow more load and generation to connect to the grid while remaining within voltage limits. This will be achieved by using more granular power quality and phase loading data to improve phase detection to enable real-time phase rebalancing in the LV network. This will also leverage UE's planned initiative on managing LV using batteries at distribution transformers. Relevant case studies such as Newington Grid Battery Storage Trial (Ausgrid) and Smart Grid: Smart City (Ausgrid) showed that battery storage can be used to reduce the load on the network asset at peak demand time and can be used to effectively mitigate power quality issues. The components included in this initiative are the LV Management solution and integration and security capability.

Dynamic forecasting capability	This initiative aims to create a predictive capability enabled by dynamic load forecasting. Some of the applications of this capability include shorter duration (4-hour) load forecasting, impacts/forecasting based on electric vehicle penetration, load disaggregation analysis to determine electric vehicle location, switching options, disaster forecasting caused by weather condition and disaster preparedness. The forecast will take into account real-time/dynamic data into considerations such as real-time demand, cloud coverage, resource estimation and DER capacity. This creates network efficiency and better fault switching decisions as the network will operate based on more accurate load data rather than overly conservative estimate. It will extend inflight initiatives on Energy Workbench and Forecasting Tool (CP-PAL). CP-PAL is also planning a joint study with RMIT on Advanced Forecasting Technology Development to be completed by 2020. It will leverage the outcomes of this work to create this capability. The components included in these initiatives include: extension of the Real-Time Grid Analytics Platform to allow additional data points (i.e. AMI data, ADMS, GIS, SINCAL, DERMS); integration with relevant systems such as ADMS, GIS, UIQ, SIQ, LV Load Flow Analysis and DERMS; security capability and dashboard.
DER - monitoring capability	This initiative aims to create a consolidated view of DER availability through data collected from Distributed Energy Marketplace and IoT Platform for Customer Sensors. It will leverage the ADMS and/or Real-Time Grid Analytics to be able to view and monitor real-time and projected DER availability. This capability will allow for: - a more effective management of outage (planned and unplanned), - a more economic management of DER or aggregated DERs as a single dispatchable resource The components included in this initiative include: dashboard, integration and security capability. The customer facing apps and customer engagement required to support the implementation will be part of the Customer Enablement pillar.
DER - automation	This initiative aims to establish a common dispatch platform for decentralised energy by automating and pulling together customer or aggregator DER/DR registration with control centre operational distribution management systems and customer/aggregator payments. It will extend the DERMS - Monitoring Capability to include functionalities such as management of dispatchable demand through end user control of dispatch, manual/automatic execution and load shedding for both emergency and economic dispatch and performance monitoring of DER programs and events. The components included in this initiative include: dashboard, integration and security capability. The customer facing apps and customer engagement required to support the implementation will be part of the Customer Enablement pillar.

Source: Powercor

D Digital Network Roadmap

Figure 12 Roadmap