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Megan Willcox
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Dear Megan

Re: AMI Network Benefits

Thank you for inviting Deloitte Access Economics to quantify the network benefits enabled by the Victorian Advanced Metering Infrastructure (AMI) metering specification. In undertaking this task, we have reviewed the analysis and models underpinning our 2011 Cost benefit analysis of the AMI Program (2011 CBA), and identified areas where assumptions can be updated to better reflect the benefits being realised by customers.

Our approach to this task involved the following steps:

1. With input from CitiPower and Powercor (the businesses), we identified the network benefits which were quantified in our 2011 CBA that are relevant to the discussion on metering specification. Note that we did not specifically review benefits to identify the potential impact of a move to national smart metering standards, nor the implications of metering contestability for the businesses' use of AMI data. Instead, we updated our 2011 CBA network benefits to estimate the proportion applicable to the CitiPower and Powercor networks.
2. We considered the assumptions underpinning each relevant network benefit, and through discussions with CitiPower and Powercor staff, reviewed:
    a. Assumptions required to allocate the Victorian benefit to customers of CitiPower and Powercor
    b. The need for amendments to the assumptions required to reflect the way that the benefit has been realised in practice by the businesses since the completion of the AMI rollout

c. Analysis that was undertaken by CitiPower and Powercor staff as part of the annual benefit reporting to the Victorian Government.

3. We revised the 2011 CBA model to estimate the net present value of relevant network benefits over the period 2016 to 2028, which are summarised in this report.

In total, our analysis has identified $99.3 million of AMI network benefits are available to be realised by CitiPower and Powercor customers over the period 2016-28. The following table presents a summary of our analysis, while the following sections provide a summary of each benefit. Key assumptions are set out in an Appendix.

	Benefit	**NPV of benefit over 2016-28 ($m)**
1	Reduction in unserved energy due to faster detection of outages and restoration times and reduction in wasted truck visits	$29.6
2	Savings from reduction in non-technical losses (theft)	$4.2
3	Avoided cost of proportion of transformer failures on overload and avoided unserved energy	$4.5
4	Ability to set emergency demand limits to share limited supply at times of network stress or supply shortage	$17.1
5	Reduced peak demand due to direct load control of air conditioners	$32.7
6	Smaller benefits	$11.2
Total benefits		**$99.3**

1 Reduction in unserved energy due to faster detection of outages and restoration times and reduction in wasted truck visits

1.1 Description of benefit

An AMI meter has an in-built capability of sending a signal back to a distributor's control room to indicate that it has no electricity supply. This signal can reduce the time needed for a distributor to respond to an outage, thereby reducing the time off supply, which has benefits for customers in terms of less unserved energy.

The Victorian electricity distribution network has a high penetration of Supervisory Control and Data Acquisition (SCADA) monitoring. The vast majority of 11kV, 22kV and 66kV high voltage (HV) feeders in the distribution network can be remotely monitored and switched at the circuit breaker (CB) supplying the HV feeders in zone substations. In some cases, segments of HV feeders can also be remotely monitored and switched by use of appropriately enabled and positioned Automatic Circuit Reclosers (ACR) and other switches. This infrastructure means that a distributor's control room will usually know that an outage has occurred before any customers ring in to a call centre to report the outage. Accordingly, an AMI meter sending a signal back to a control room that it has no supply will have little benefit, in terms of reducing outage notification time, for an outage on a HV feeder which is SCADA enabled. This limits the potential benefit to the low voltage (LV) network. We note that CitiPower and Powercor do have some non-SCADA monitored fused HV network, for example, spurs. For these sections of the network, AMI signals can provide a benefit by reducing outage notification time.

An outage occurring on the LV system can affect up to a few hundred customers, depending on the population density of the area it supplies and the size of the distribution transformer supplying those customers. A fault on the LV system will usually result in the operation of an LV fuse. This fuse will need to be manually replaced to restore supply. Thus without AMI, the control room may not know that an LV outage has occurred until customers ring in to the call centre to report an outage.

AMI provides some benefit for LV outages, as it enables the control room to quickly verify if an outage is affecting a single premise or an isolated set of customers.. During discussions, the businesses indicated that as this AMI benefit results in less time between an outage occurring and being identified, it does not impact SAIDI, which measures the time between an outage being identified and rectified. Nevertheless, it allows those affected customers to be remotely identified and appropriate schedules developed for the restoration of their supply

AMI meters will improve the distributors' ability to respond to multiple HV feeder and LV outages resulting from severe storm conditions. Whilst control rooms currently have knowledge, via SCADA, of the HV feeder outages due to the storm conditions, they may not know about embedded LV faults. The HV feeder faults can be repaired and supply (thought to be) restored, however the LV embedded faults can remain. There have been instances of single customers being off supply for a number of days as a result of this scenario.

There is also potential benefit in reduced restoration times in semi-rural and rural areas, where repair crew notification time and travelling time to a fault are significant components of overall outage duration time.

In addition, this particular AMI functionality provides additional information that a control room and its associated Outage Management System can use to analyse and prioritise outage restoration. Is it likely that given this additional information, innovative strategies will be developed over time to improve outage times. However, as we noted in our 2011 CBA, this additional benefit is difficult to quantify.

In our 2011 CBA, we estimated that CitiPower customers would realise a 3% improvement in SAIDI as a result of the AMI rollout, while Powercor customers would realise a 5% improvement in SAIDI. This was based on expected improvements on LV network monitoring for CitiPower and Powercor, semi-rural and rural area time improvements for Powercor, and outage management innovation for both CitiPower and Powercor.

During discussions, the businesses indicated that it is realising a benefit of 4.5 minutes saving in duration of area faults due to the AMI rollout. This saving is in the time taken to identify faults, not a reduction in restoration time between fault identification and fault rectification which is measured by SAIDI.

The businesses also indicated that due to the ability for the AMI systems to directly contact ('ping') a customer's meter to determine whether a fault exists on the customer's or the network's assets, significant savings are being realised directly by customers in the avoidance of wasted truck visit fees. Prior to AMI, customers who call to notify of an outage, where a truck is sent and the fault is later identified to be on the customer's side of the meter, a wasted truck visit fee of $350 applies. CitiPower and Powercor estimate that they are saving approximately 13 wasted truck visits per day due to AMI, which is reflected in data reported in the businesses' Category Analysis Regulatory Information Notice templates submitted to the AER, when comparing pre and post-AMI rollout data.

1.2 Calculating the benefit

To estimate the value of this benefit for CitiPower and Powercor customers over 2016-28, we have:

1. Using published SAIDI and SAIFI data over 2010-15, estimated the average frequency and duration of an outage for both CitiPower and Powercor customers. Due to the variability of these reliability metrics, we excluded both the highest and lowest years of SAIDI and SAIFI data, consistent with our approach in the 2011 CBA
2. Using the businesses' estimate of 4.5 minutes saving per outage, calculated the annual avoided hours off supply for CitiPower and Powercor customers, based on the average annual frequency and duration of outages above
3. Based on average customer load (kW) data provided by the businesses, estimated the avoided unserved energy in MWh as a result of AMI
4. Using the Value of Customer Reliability (VCR) estimates developed by the Australian Energy Market Operator (AEMO), calculated the assumed value of avoided unserved energy.
5. Separately calculated the value of the avoided wasted truck visit fees, based on the businesses' stated 13 visits avoided per day.

We estimate that the total value of this benefit in NPV terms over 2016-28 is $29.6 million.

2 Savings from reduction in non-technical losses (theft)

2.1 Description of benefit

Internationally, non-technical losses (or theft of electricity) have a significant impact on distributor and retailer revenue. Many sites where electricity theft occurs are associated with other criminal activities. It is more difficult to steal electricity where a smart meter is installed.

During our 2011 CBA, the Victorian distributors indicated in discussions that electricity theft was not a material issue in Victoria. However, given international experience, we considered that this was likely to be an under-realised issue, and accordingly calculated the benefit associated with the AMI rollout.

Our 2011 CBA assumed that theft in Victoria is equal to 0.5% of energy sales. We assumed that the uncovering of this theft would result in a 50% reduction in energy use for the theft sites (assuming that thieves will choose to continue to use electricity, however will significantly reduce their consumption once being charged for it). To value this change, we used Victorian pool price data and forecasts.

We recognise that a significant proportion of this benefit would have been realised as a result of the AMI installation process, which is now completed. However, discussions with the businesses have confirmed that the AMI systems do enable ongoing power quality data analysis which can be used to identify non-technical losses. We have also reviewed anecdotal evidence that other Victorian distributors have uncovered significant theft through the analysis of AMI power quality data, however CitiPower and Powercor have not yet initiated this analysis on their systems, but expect to do so in the near future.

We have not found any reliable information to suggest that a revision to the approach and assumptions underpinning the calculation of this benefit is needed. Based on the anecdotal evidence of another distributor, the assumption that 0.5% of electricity distributed in Victoria is subject to theft is likely to be conservative, however we have maintained this assumption in the benefit estimate for this report. We have assumed that CitiPower and Powercor will begin to use this functionality and realise the benefit from 2018.

2.2 Calculating the benefit

To estimate the value of this benefit for CitiPower and Powercor customers over 2016-28, we have:

1. Identified the proportion of energy distributed subject to non-technical losses in CitiPower and Powercor (0.5% of energy sales) over 2016-28, taking into account forecasts of customer numbers and energy use
2. Estimated the value of the non-technical losses using the average Victorian Pool Price, assuming that uncovering theft results in offenders reducing their consumption by 50%.

We estimate that the total value of this benefit in NPV terms over 2016-28 is $4.2 million.

3 Avoided cost of proportion of transformer failures on overload and avoided unserved energy

3.1 Description of benefit

Distribution transformers periodically fail when overloaded, sometimes resulting in outages as well as the costs of repairing equipment. AMI enables better monitoring of the loads on transformers, as demand at each point in the network is known to the distributor.

In our 2011 CBA, we considered that AMI provides a benefit in the distributor being able to better monitor its equipment and therefore reduce the need to replace some transformers by proactively repairing them. Given fewer transformers will fail, we also consider there is some value in the associated avoided unserved energy.

During discussions with the businesses, it was identified that 30 minute AMI power quality data has the potential to assist planners to identify transformers on overload and avoid failures, reducing the capital cost of failed transformers, and the outage time associated with transformer failures. CitiPower and Powercor are currently collecting and analysing power quality data for 27,000 customers.

The businesses provided data on the number of transformers failing on overload each year over the period 2009 to 2016. The data suggested that since the AMI rollout, the average number of transformers failing on overload has already reduced by 10 per annum across the CitiPower and Powercor networks, with the potential for greater reduction once use of the power quality data is embedded in network planning and decision making. We have used the actual data on transformers failing on overload to estimate the annual benefit being realised by customers, as outlined below, noting that this is likely to be a conservative estimate given the potential for further analysis of power quality data.

3.2 Calculating the benefit

To estimate the value of this benefit for CitiPower and Powercor customers over 2016-28, we have:

1. Drawing on data provided by the businesses on the number of transformers failing on overload per annum both prior to AMI and after AMI, calculated the average number of transformer failures being avoided as a result of the introduction of AMI, being ten per annum.
2. Validated our original 2011 CBA assumptions on the additional time required to repair or replace a transformer that failed on overload (6 hours) and the cost per transformer ($50,000).
3. Using the Value of Customer Reliability (VCR) estimates developed by the Australian Energy Market Operator (AEMO), calculated the assumed value of avoided unserved energy.

We estimate that the total value of this benefit in NPV terms over 2016-28 is $4.5 million.

4 Ability to set emergency demand limits to share limited supply at times of network stress or supply shortage

4.1 Description of benefit

During periods of constrained supply or in emergency situations, a demand limit can be determined directly in each household's AMI meter, without requiring direct load control of appliances. Our 2011 CBA assumed that this demand limit would be set by the market operator (AEMO), and could vary between events.[1] We assumed that, should the determined demand limit be exceeded by the household's consumption, the disconnect in the meter would open for a minimum 'safe period' (typically 5 minutes), completely turning off the flow of electricity. Once that 'safe period' has expired, provided the household demand has reduced to the determined demand limit or below, the house would be re-connected and electricity would again flow. The customer would need to be informed that during the 'safe period' of outage, they need to decide what appliances/loads to switch off in order to prevent being disconnected again.

Discussions with the businesses revealed that the use of emergency demand limits has in practice varied from the approach we anticipated in the 2011 CBA. To date, CitiPower and Powercor have not used demand limits to share supply at times of network stress, however we note that the last significant emergency load shedding event for the businesses occurred in 2009.

Regardless of the businesses' activities to implement this AMI functionality, it is available as a result of the AMI systems. We have not reviewed any information to suggest that our approach to estimating this benefit should be amended, and accordingly we have applied the same core assumptions as our 2011 CBA, adjusted for the proportion of load shedding realised in CitiPower and Powercor's networks. This adjustment was based on the proportion of load shedding in Victoria that occurred in CitiPower and Powercor's networks in 2009.

We have assumed this benefit will be realised from 2018, but that it will take a few years for the businesses to optimise the approach to messaging customers and therefore the full benefit will not be realised until 2020.

We note that the ability to selectively control loads during times of network stress provides additional benefits, for example, the ability for the networks to ensure that traffic lights remain on and rail boom gates remain operational during an emergency increases road safety for Victorians. These benefits have not been quantified in our analysis.

4.2 Calculating the benefit

To estimate the value of this benefit for CitiPower and Powercor customers over 2016-28, we have:

1. Drawing on information provided by the businesses, estimated the likely available demand reduction from residential CitiPower and Powercor customers at times of emergency and network constraint.
2. Estimated the customer value of lost load at times of emergency and network constraints, which we have assumed is equal to residential customer VCR, discounted by 25% to account for the non-linearity of VCR, consistent with the approach taken in our 2011 CBA.

We estimate that the total value of this benefit in NPV terms over 2016-28 is $17.1 million.

[1] Note that the retailer does not have a role in determining emergency demand limits, and that this function is not related to setting demand limits for credit control purposes.

5 Reduced peak demand due to direct load control of air conditioners

5.1 Description of benefit

The Home Area Network (HAN) functionality of AMI meters enables communication between the distributor or retailers, and customer appliances, where those appliances are either 'smart (Zigbee) enabled' or are retro-fitted with a communicating device. Direct load control involves using communications devices to limit (reduce or cancel) the supply of electricity to controlled appliances at times of peak demand.

As we noted in our 2011 CBA, results from Australian trials suggest that providing customers with positive incentives or rewards for engaging in load control programs to reduce their peak demand can drive significant savings. Results from voluntary direct load control programs in Utah, Arizona and Nova Scotia indicate customers who opt into load control contracts will reduce their peak demand by 15%.

Our 2011 CBA assumed that, given peak demand days in Victoria are always associated with high temperatures, the majority of benefits associated with load control will likely be driven by savings in air conditioner load. We assumed that in order to participate in direct load control, customers would need to have a device fitted to their air conditioner, at a cost of $75.

In calculating this benefit for the 2011 CBA, we assumed that a maximum of 25% of Victorian customers would take up direct load control from 2020 (with 1% commencing in 2014), and would deliver savings of 15% on their peak demand.

Discussions with the businesses revealed that, while not currently available for CitiPower and Powercor customers, direct load control of air conditioning is being evaluated. We have assumed this benefit will begin to be realised from 2021, with load control take-up reaching a maximum on 25% of customers from 2027.

5.2 Calculating the benefit

To estimate the value of this benefit for CitiPower and Powercor customers over 2016-28, we have:

1. Estimated the proportion of CitiPower and Powercor customers with air conditioners (72%, consistent with our 2011 CBA)
2. Estimated the proportion of total peak load associated with domestic air conditioner use, consistent with our approach in the 2011 analysis
3. Assumed a direct load control take up rate trajectory consistent with our 2011 CBA, being that from 2027, 25% of CitiPower and Powercor customers would participate in the direct load control tariff and reduce their peak demand by 15%
4. Estimated the benefit of this lower peak demand based on an annual capital charge, consistent with our 2011 CBA
5. Subtracted the cost of the load control devices ($75 per customer) from the peak demand benefit.

We estimate that the total value of this benefit in NPV terms over 2016-28 is $32.7 million.

6 Smaller benefits

6.1 Description of benefit

In addition to the benefits which were quantified separately, our 2011 CBA incorporated some additional benefits associated with AMI for which a high level estimate of the value was developed.

As part of this project, we have reviewed these smaller benefits, and identified five network benefits quantified in 2011 that are relevant to the discussion on metering specification. As they were estimated at the Victoria-wide level, we have pro-rated these five benefits according to publicly available data, as set out in the following table. We have not conducted any further analysis of these benefits.

Smaller benefit	Deloitte 2011 Value (NPV $m 2012 to 2028)	Pro-rata basis	Pro-rata $2011 $m value - CP and PC	Updated value - $2016 $m NPV to 2028
Reduced cost of network loading studies for network planning	$6.80	2016 Opening Regulated Asset Base	$2.93	$3.05
Avoided cost of proportion of HV/LV transformer fuse operations on overload	$6.80	2015 Transformer Capacity	$3.18	$3.31
Avoided cost of supply capacity circuit breaker	$5.44	2016 Opening Regulated Asset Base	$2.34	$2.44
Avoided cost of end of line monitoring	$5.44	2015 Regulated Asset Base – Distribution System Assets	$2.30	$2.39
Total Smaller Benefits	**$24.5**		**$10.7**	**$11.2**

7 Unquantified benefits – Other load control benefits

CitiPower and Powercor currently have around 250,000 customers on a hot water load control tariff. As part of this tariff, the businesses are able to control when electric hot water systems switch on and off. Prior to the AMI rollout, load control was carried out through timeswitches which were set to switch hot water load on and off at a predetermined time (11pm to 7am).

AMI allows distributors to more dynamically manage the time that controlled load comes on and off, providing the ability to stagger hot water peaks and reduce constraints on the network.

The businesses indicated that they are intending to shift hot water load control on certain feeders and phases into the middle of the day to provide loads to consume the PV generation that otherwise is causing voltage rise problems for the network, which will deliver additional benefits.

In addition, the businesses have highlighted that dynamic load control can be used to bring a greater proportion of feeders closer to planning ratings, which reduces the potential load at risk for planned and unplanned outages. Finally, the ability to dynamically control hot water load enables distributors to gradually ramp up/off switching times, enabling a smoother voltage change in the load switching, which assists with reducing the quality of supply issues.

Although the businesses are currently using the AMI technology to stagger hot water load, there is insufficient data to estimate the benefits of this additional dynamic switching in terms of reducing peak demand, deferring expenditure and improving quality of supply.

We note that the ability to directly control specific load using AMI will bring significant benefits once electric vehicle take up accelerates and home charging impacts the demand on the network.

Yours sincerely

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