



## DRAFT REPORT

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# Advanced Interval Meter Communications Study

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## EXECUTIVE SUMMARY

In July 2004, the Essential Services Commission (ESC) issued a decision<sup>1</sup> requiring the mandatory rollout of interval meters for Victorian electricity customers according to the following schedule:

- By 2008 for all customers consuming more than 160 MWh per year, with new and replacement installation commencing in 2006;
- By 2011 for all customers using between 20 MWh and 160 MWh per year with off-peak metering or three-phase metering, with new and replacement installation commencing in 2006;
- By 2013 for all customers below 20 MWh per year with off-peak metering or three-phase metering, with new and replacement installation commencing in 2006; and
- On a new and replacement basis for all customers with single-phase, non-off-peak metering, with installation commencing in 2008.

This decision does not include a date by which all customers must have interval meters. Given the normal replacement rate, unless there was a subsequent decision to accelerate interval metering installation for all customers, it would take many decades before all single-phase, non-off-peak meters would be replaced.

The Interval Meter Rollout (IMRO) decision does not require any communications equipment to be installed as part of the rollout. Although this does not itself prevent the rollout of meters with communications capability, distributors are intending to rollout meters that are manually read. A derogation from the National Electricity Rules only maintains the distribution companies' monopoly on meter provision and meter data services in relation to meters that do not have remote communications capability. Although this enables retailers to become the Responsible Person in regard to the rollout of interval metering with communications, retailers also have no plans to rollout large volumes of interval metering with remote communications.

This study investigates whether or not it would be cost-effective to add communications to the IMRO meters. Adding communications could produce additional benefits such as reducing meter reading costs, allowing for remote connect/disconnect, and providing a platform for enhanced load management features. This study also examines whether accelerated deployment of IMRO meters with communications would be beneficial.

More specifically, this study examines the net benefits of the following two major scenarios, relative to the costs and benefits of the IMRO meter deployment plan:

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<sup>1</sup> *Mandatory Rollout of Interval Meters for Electricity Customers*, Final Decision, Essential Services Commission Victoria, July 2004

- **Scenario 1:** Add communications capabilities to meters that continue to be rolled out according to the existing IMRO schedule.
- **Scenario 2:** Make the modifications included in scenario 1, and also accelerate the IMRO rollout so that all meters are converted to IMRO meters with communications in the four years from 2009 to 2012 (inclusive).

Within each scenario, we identified and sought to evaluate the costs and benefits of four different technologies for advanced meter communications:

- a) Wireless networks (GPRS or CDMA);
- b) Distribution Line Carrier (DLC);
- c) Mesh radio; and
- d) Power Line Carrier (PLC).

For each scenario and each communications technology option, there is the capability to read meters remotely, and also the capability for remote connection and disconnection.

Given equivalent end-use functionality, the benefits of advanced communications do not depend on the technology used. Thus we present a single set of results for the benefits of scenario 1, which would apply whatever technology was deployed, and a single set of results for the benefits of scenario 2, again independent of the technology deployed in scenario 2.

In contrast, costs vary widely, depending on the technology deployed. We sought to obtain cost information for each of the four system options described above for the two deployment scenarios, for a total of eight deployment/technology combinations. However, we were not able to obtain costs for mesh radio or PLC technologies for the IMRO deployment scenario.

The DLC and mesh radio technologies are not suitable for use across the whole State, due to there being insufficient density of customers in remote rural areas. Thus, these technology options must be supplemented with technology that can be used in rural areas for a relatively small percentage of customers in Victoria. For our analysis, we assumed that a wireless connection (GPRS/CDMA) would be used in rural areas under the IMRO roll out scenario (scenario 1), and PLC would be used in remote areas in combination with DLC and mesh radio for the full deployment scenarios (scenario 2).

In summary, we have developed cost estimates for the following six deployment/technology combinations:

- 1a: IMRO deployment, public wireless network;
- 1b: IMRO deployment, DLC private network (with wireless network for rural);
- 2a: Full deployment, public wireless network;

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- 2b: Full deployment, DLC private network (with PLC for rural);
- 2c: Full deployment, Mesh radio private network (with PLC for rural); and
- 2d: Full deployment, PLC private network.

Table 1 contains estimates of costs, benefits and net benefits for each of the six deployment/technology scenarios that were examined. In all cases, these are relative to the costs and benefits of the IMRO deployment plan. All values in the table represent the net present value in 2005 dollars over the 18 year life of the investment. Three of the six scenarios have positive net benefits relative to IMRO: the accelerated rollout DLC private network at \$79 million, the accelerated mesh radio private network at \$26m and the accelerated rollout PLC private network at \$61 million. The IMRO schedule DLC private network solution has marginally negative net benefits.

The two scenarios using the public wireless communication systems (GPRS/CDMA) are significantly more costly than the private network options. For the IMRO deployment schedule, incremental costs exceed incremental benefits by \$269 million. For full deployment, incremental costs exceed incremental benefits by \$523 million.

**Table 1: Cost Benefit Analysis Results**

Scenario		Net Present Value (NPV)		
Rollout	Communications	Benefits (\$m)	Costs (\$m)	Net Benefits (\$m)
1: IMRO	(a) Wireless	243	512	-269
	(b) DLC		254	-12
2: Accelerated Rollout	(a) Wireless	432	954	-523
	(b) DLC		353	79
	(c) Mesh radio		406	26
	(d) PLC		371	61

The benefits are constant across the various technologies, varying only between the IMRO schedule scenario and the full deployment scenario. With a total NPV of \$432 million, benefits under the full deployment scenarios are around 60 percent greater than they are under the IMRO schedule scenarios, where benefits equal \$243 million. The most significant benefit derives from the avoided cost of manually read, normal cycle reads. This avoided cost accounts for about 45% of the total benefits for the full deployment scenarios, and about 55% of total benefits for the IMRO schedule scenario.

The second largest share of benefits, at 35 percent of total benefits for the full deployment scenarios, is the avoided cost of special meter reads and de-energisation / re-energisation. The \$28 million savings associated with avoided battery replacement accounts for about 6.5 percent of the total benefits for the full deployment scenarios. The demand response benefits, at \$29 million for the full deployment scenarios, accounts for 7 percent of total benefits. Demand response benefits are negative for the IMRO schedule scenarios because of the assumed three-year delay in rollout of any interval meters under these scenarios, compared with the current IMRO schedule.

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Avoided retailer costs account for 5 percent of benefits. An additional \$9 million in benefits is achieved in the full deployment scenarios (\$3 million in the IMRO scenarios) by eliminating the need for Portable Data Entry devices used by meter readers.

The list of benefits included in our analysis is quite narrow, essentially including only:

- the avoided cost of regular and off-cycle reads and associated PDE costs;
- avoided retail costs mainly related to call centre activity;
- the avoided cost of battery replacement; and
- the benefits of price-induced demand response associated with the incremental customers on interval meters for the full deployment scenario relative to the IMRO schedule.

There are many other quantifiable benefits that will almost certainly accrue from full scale deployment of advanced metering that we were not able to quantify due to lack of information from stakeholders and the relatively high-level nature of the project (compared with the “drill-down” that occurs when company-specific business cases are completed). These other quantifiable benefits include better outage detection, elimination of estimated bills, and elimination of profiling for settlement. Typical business case analysis projects in North America have found that quantifiable benefits such as these can amount to 100 to 300 percent of the savings associated with elimination of normal meter reads. In addition, there are many non-quantifiable benefits that may also accrue, such as faster and more accurate settlement, improved customer satisfaction, and product/service innovation. We are confident that a more thorough investigation of benefits would substantially improve the already attractive net benefit estimates reported here.

The present value of capital and operating costs over the life of the investment for the full deployment scenarios vary dramatically between the public and private network systems, from a low of \$353 million for the DLC scenario to a high of \$954 million for the wireless public network scenario. The very high costs for the public network options are due in part to the assumed need to replace the communication modules after ten years, due to the likely obsolescence of the GPRS/CDMA technology, and in part to the network usage charges associated with reading more than 2 million meters.

The analysis presented in this report indicates that the net benefits of full deployment of interval metering with two-way communications in Victoria are significant. Even though we did not quantify many of the potential benefits that are possible with advanced metering, the present value of net benefits relative to IMRO is estimated to equal \$79 million for the DLC scenario. In many installations of advanced metering in North America, it has been found that realised benefits exceeded the benefits estimated during the business case leading up to a decision to deploy, and we have no reason to believe that a similar result would not be achieved in Victoria. **As such, we recommend that the Victorian Government and electricity supply industry should progress activities to result in accelerated rollout of interval metering with advanced communications across Victoria, in accord with scenario 2 as presented in this study – as an enhancement of the existing IMRO decision.**

Our analysis was based on a schedule in which rapid deployment of advanced metering would commence in January 2009. While there are many additional steps that need to occur between a decision to move forward and putting the first meter in place, the primary reason for delaying implementation until 2009 in our analysis was a belief by some that ramping up more quickly could encounter a skilled labour shortage that would either prolong or delay the deployment process. We believe that this potential barrier should be explored more fully as one of the immediate next steps, as it is likely that other issues could be addressed within the next 12 to 18 months, thus allowing for deployment to start sooner, and for Victoria to begin receiving the benefits of advanced metering more quickly.

In order to allow for these important further steps to be undertaken, and to avoid the additional costs that would be incurred if manually read interval meters were to begin deployment in 2006, only to be replaced soon thereafter with communicating meters, **we recommend that the planned start of IMRO meter deployment be deferred.** At a minimum, the deferral should initially be for one year, during which a final decision can be made regarding the new recommended policy. As indicated above, we believe it is possible to settle all issues in time to allow full-scale deployment of advanced meters to commence no later than 1 January 2008, and perhaps sooner (assuming no shortage of skilled labour).

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**We recommend that as a first step towards implementation of advanced meter the issue of the responsible person for meter service provision and meter data provision needs to be addressed.** As noted above, the National Electricity Rules make the retailer the Responsible Person for remotely read interval meters. In some ways, it would be easier for a rollout if the distribution business was the Responsible Person, but this would require a rule change. It is therefore suggested that a way forward is to retain the retailer as the Responsible Person for both meter service provision and meter data provision, but have the distribution businesses mandated to rollout advanced interval meters to all Victorian electricity customers. The retailers could then choose whether they wished to use the distribution businesses' metering and communications or appoint other providers. Where a retailer chooses not to use the distribution business' infrastructure, there would need to be a guarantee that the distribution business is still recompensed for everything except actual direct avoided costs of someone choosing to use another network. With this option, there would continue to be a level of competition in metering and there would also be no change required to the National Electricity Rules. It is also recommended that the distribution businesses be required to provide guaranteed service levels for all advanced interval metering services provided to retailers.

Another important step towards implementation is the harmonisation of functional requirements such that there is a level of common functionality between advanced metering systems in each distribution business area, so that retailers can offer the same functional options of customers across the state. **We recommend that the Victorian Government facilitate the development, in conjunction with the industry and the ESC, of a common functional requirement that will be mandated across the various AMI systems that will operate across the state.** There may also be the need for a new metrology procedure to be developed for these types of meters.

The next important activity is the conducting of technology trials and pricing experiments. Technology trials are important in demonstrating that certain technologies are adequate for meeting the requirements of advanced metering in the urban and rural areas. Further trials allow better understanding of the performance of systems and the operational issues associated with installations and operations. Pricing experiments could be useful in estimating the potential magnitude of demand-response savings from alternative pricing. It is noted that trials are not needed in order to decide to move forward, as the estimates presented here are generally based on quite conservative assumptions about incremental costs and benefits. For example, the net benefits would still be positive if there were no demand response benefits at all, so there is no reason to wait to develop better estimates of demand response before deciding to move forward. **We recommend that the Victorian Government facilitate a co-ordinated approach to AMI trials**



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The final co-ordinated activity required is implementation planning. This is where the final business case for implementation is developed, presented and approved. All the details of common functionality to meet distribution business and retail business interactions are defined carefully and full functional and operational specifications are developed. . **We recommend that DOI in conjunction with the ESC provide detailed guidelines regarding the content and approach to the business cases that each distributor would develop, and establish a schedule for development and review of the business cases prior to approving implementation.**

## 1. INTRODUCTION

This report gives the results of a study that has been undertaken to analyse the benefits of costs that may be incurred in a roll-out of interval metering and advanced communications technology to electricity meters in Victoria.

### 1.1. BACKGROUND

In July 2004, the Essential Services Commission (ESC) issued a decision<sup>2</sup> requiring the mandatory rollout of interval meters for Victorian electricity customers according to the following schedule:

- By 2008 for all customers consuming more than 160 MWh per year, with new and replacement installation commencing in 2006;
- By 2011 for all customers using between 20 MWh and 160 MWh per year with off-peak metering or three-phase metering, with new and replacement installation commencing in 2006;
- By 2013 for all customers below 20 MWh per year with off-peak metering or three-phase metering, with new and replacement installation commencing in 2006; and
- On a new and replacement basis for all customers with single-phase, non-off-peak metering, with installation commencing in 2008.

This decision does not include a date by which all customers must have interval meters. Given the normal replacement rate, unless there was a subsequent decision to accelerate interval metering installation for all customers, it would take many decades before all single-phase, non-off-peak meters would be replaced.

The Interval Meter Rollout (IMRO) decision does not require any communications equipment to be installed as part of the rollout. Although this does not itself prevent the rollout of meters with communications capability, distributors are intending to rollout meters that are manually read. A derogation from the National Electricity Rules only maintains the distribution companies' monopoly on meter provision and meter data services in relation to meters that do not have remote communications capability. Although this enables retailers to become the Responsible Person in regard to the rollout of interval metering with communications, retailers also have no plans to rollout large volumes of interval metering with remote communications.

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<sup>2</sup> *Mandatory Rollout of Interval Meters for Electricity Customers*, Final Decision, Essential Services Commission Victoria, July 2004

This study investigates whether or not it would be cost-effective to add communications to the IMRO meters. Adding communications could produce additional benefits such as reducing meter reading costs, allowing for remote connect/disconnect, and providing a platform for enhanced load management features. This study also examines whether accelerated deployment of IMRO meters with communications would be beneficial.

The study is limited to consideration of metering for customers with annual consumption not exceeding 160 MWh. Customers with consumption above this level are treated differently, and consideration of their metering arrangements is outside the scope of this study. Nothing in this report is intended to change the existing IMRO requirement that interval meters should be rolled out by 2008 for all customers consuming more than 160 MWh per year, with new and replacement installation commencing in 2006. Discussion in this report of potentially deferring IMRO does not apply to customers with annual consumption above 160 MWh.

## **1.2. TERMS OF REFERENCE FOR THIS STUDY**

Further background and the terms of reference for this study can be found in Appendix A. It should be noted that the terms of reference have evolved over the course of the study through our meetings and discussions with the Project Steering Group.

## **1.3. THE ROLE OF CRA & IMPAQ CONSULTING**

This study was awarded to CRA International Pty Ltd (CRA) and Impaq Consulting. The lead contractor was CRA with overall responsibility for the project. Impaq Consulting undertook the role of research on costs of various technologies, and assisted CRA in other aspects of the work, including workshop presentations, and contributing to the production of the project deliverables. CRA has also utilised the services of Dr. Gary Fauth and Michael Wiebe, two consultants who have been involved in many of the advanced metering studies and project implementations in the US.

## **1.4. ACKNOWLEDGEMENT**

We would like to acknowledge the contributions made by the Victorian distributors, retailers and vendors, as well as the ESC and NEMMCO, all of whom spent time with us, and together provided us with substantial information and data that we have used in this study. We thank you all for your participation in this important study.

## **1.5. STRUCTURE OF THIS REPORT**

The remainder of this report is structured as follows:

Section 2 contains an overview of the approach that we used in order to quantify benefits and costs in this study.



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Sections 3 and 4 summarise the input assumptions and data that were used for the cost and benefit estimates, respectively. Section 4 also includes discussion of benefits that have not been quantified in this analysis.

Section 5 presents the results of the analysis.

Section 6 presents our recommendations and next steps for consideration by Government and industry.

## 2. OVERVIEW OF APPROACH

This section contains an overview of our approach to this study. It details both the analytical approach as well as our approach to data gathering.

### 2.1. ANALYTICAL APPROACH

#### 2.1.1. Two Scenarios

This study examines the net benefits of the following two major scenarios, relative to the costs and benefits of the IMRO meter deployment plan:

- **Scenario 1:** Add communications capabilities to meters that continue to be rolled out according to the existing IMRO schedule.
- **Scenario 2:** Make the modifications included in scenario 1, and also accelerate the IMRO rollout so that all meters are converted to IMRO meters with communications in the four years from 2009 to 2012 (inclusive).

At the highest level, the approach taken in this study simply compares the costs for each scenario, incremental to the cost of the IMRO meter deployment plan, with the benefits for each scenario, also incremental to the benefits that arise from the IMRO plan. The intent is to estimate the present value of the net economic benefits of the various scenarios.

The economic benefits and costs considered in the study are intended to represent changes in the uses of societal resources resulting from implementation of the policies under consideration. That is, they are not intended to represent the specific costs or benefits that would accrue to any particular stakeholder, such as a retailer or distributor. Income transfers from one party to another are not considered as either a cost or a benefit in this analysis. For example, a reduction in energy theft or lost revenue due to unknown customers represent transfers from one stakeholder to another, not economic resources that could be reallocated to better use if they are reduced through better theft detection or reductions in the number of unaccounted for customers. On the other hand, if a benefit-cost analysis were being done from the perspective of a distributor or retailer, these factors could be very important in the overall analysis. The specific benefits and costs that are considered in this study are discussed below.

### 2.1.2. Technology Options

In addition to the two broad deployment scenarios summarised in the previous section (e.g., IMRO deployment and rapid deployment), we also examined multiple technology options for remote meter reading. In terms of capital hardware investments, an advanced metering system typically has four components: a meter; a communication module (typically embedded in the meter); a concentrator (that collects data from a number of meters before sending the data upstream to a meter data collection point where all meter data is stored); and the communication infrastructure (which can be either a public or private network). We obtained cost information on the four technology options summarised below<sup>3</sup> as these were determined to be the options that are most likely to emerge in the Australian market if wide scale deployment of advanced metering goes ahead.

#### a) Wireless Networks (GPRS or CDMA)

With this technology, the communications to and from the meters relies on existing public networks: GPRS networks for metro (urban) areas; CDMA networks for rural areas where GPRS is not available. With this system, there are no intermediate data concentrators or transceivers; a Metering Data Agent (MDA) would communicate directly with each meter. This type of remote meter reading solution is currently used on types 1 to 4 meters in the NEM, and has been working effectively for several years. The GPRS or CDMA modem is integrated into the meter so as to have just one combined unit to install at customers' premises.

It is expected that GPRS and CDMA will be replaced as a communications technology during time horizon of this study. Therefore, as a prudent measure, allowance has been made in our analysis for the replacement of the communications modem at year 10.

It has been suggested that 3G technology could be utilised instead of GPRS/CDMA to avoid technology obsolescence. It is however noted that:

- Currently 3G has a relatively small geographic footprint and almost no coverage in rural areas
- 3G modems are scarcely available and indicative pricing is many times that of GPRS or CDMA modems.

Because of these factors 3G has not been further considered in this study.

#### b) Distribution Line Carrier (DLC)

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<sup>3</sup> These options are described more fully in an Appendix.

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Distribution Line Carrier (DLC) systems use the Low Voltage (LV) distribution network as the communications medium between meters and data concentrators located at distribution transformers. This technology has relatively low end-point costs, but requires many more concentrators than the other options. DLC typically achieves data communication rates between data concentrators and meters of between 5kb/sec and 30kb/sec.

c) Mesh Radio

Mesh radio is a radio-based technology for reading meters, which uses meters as repeaters in a mesh configuration. The meter concentrator receives and transmits signals to meters, which in turn pass these signals on to other meters. The layout of the mesh is such that meters may be able to communicate with several meter collectors, so that if the path to one is not operational then paths to other meter collectors can be used. Meter collectors can interact with about 1000 meters in a mesh. Meter collectors can communicate with a network management system using a range of technologies; a usual approach is to use a carrier's GPRS network to communicate with meter collectors. Mesh radio achieves data communication rates that are similar to the communication rates achieved with DLC.

d) Power Line Carrier (PLC)

Power Line Carrier (PLC) communications can maintain a signal across distribution transformers. PLC has been used by electricity utilities for many years, particularly for protection signalling on transmission lines. PLC signals are sent over the Medium Voltage (MV) and Low Voltage (LV) network to meters from zone substations, and the signals are also received back from meters at zone substations. PLC data communication rates are slow. Outbound to meters it is of the order of 2 to 4 bits/sec. Inbound from meters to zone substations, the data rate is of the order of 30 to 300 bits/sec, depending on the number of meters communicating in parallel. PLC can be less expensive than other systems when customer density is low. The architecture in this study assumes that GPRS is used as the means to communicate between a network management system and transceivers at each zone substation. The GPRS communications link has been included in the costing package, though it may not be necessary, as all zone substations have communications connected already.

Given equivalent end-use functionality, the benefits of advanced communications do not depend on the technology used. Thus we present a single set of results for the benefits of scenario 1, which would apply whatever technology was deployed, and a single set of results for the benefits of scenario 2, again independent of the technology deployed in scenario 2.

In contrast, costs vary widely, depending on the technology deployed. We sought to obtain cost information for each of the four system options described above for the two deployment scenarios, for a total of eight deployment/technology combinations. However, we were not able to obtain costs for mesh radio or PLC technologies for the IMRO deployment scenario.

The DLC and mesh radio technologies are not suitable for use across the whole State, due to there being insufficient density of customers in remote rural areas. Thus, these technology options must be supplemented with technology that can be used in rural areas for a relatively small percentage of customers in Victoria. For our analysis, we assumed that a wireless connection (GPRS/CDMA) would be used in remote areas under the IMRO roll out scenario (scenario 1), and PLC would be used in remote areas in combination with DLC and mesh radio for the full deployment scenarios (scenario 2).

In summary, we have developed cost estimates for the following six deployment/technology combinations:

- 1a: IMRO deployment, public wireless network;
- 1b: IMRO deployment, DLC private network (with public wireless network for rural);
- 2a: Full deployment, public wireless network;
- 2b: Full deployment, DLC private network (with PLC for rural);
- 2c: Full deployment, Mesh radio private network (with PLC for rural); and
- 2d: Full deployment, PLC private network.

### 2.1.3. Functionality Considered in this Study

In this study, our base case against which we are assessing costs and benefits is the IMRO decision. This enables innovative pricing regimes to be developed by retailers and distributors, supported by the interval meter data that IMRO will provide. At a minimum, advanced communications would also provide remote meter reading capability. In our workshops we termed this “**level 1**” functionality.

One of the key questions that we asked in the workshops that were conducted and in the Requests for Information that was sent out was the extent to which we should also examine other functionality which, while perhaps more costly, would generate additional benefits. For example, we considered whether we should include in the costing:

- Provision of a contactor to allow for remote connection and disconnection;<sup>4</sup>
- More frequent regular cyclic meter reading; and
- IT systems to enhance distribution businesses’ use of interval data for additional functions, in order to provide for more operational benefits for the distribution businesses.

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<sup>4</sup> The IMRO specification already includes a contactor for switching hot water and some space heating loads to run on off-peak tariffs, but this specification does not extend to remote connection or disconnection.

It was also suggested that we should consider costing in-home displays to assist customers in responding to price signals in their tariff, but we are not aware of any credible empirical evidence that providing this type of information to customers increases demand response.

There are two items that we have included in our benefit-cost analysis above the functionality of “level 1” discussed at workshops.

- We have allowed for the capability for daily reading of meters with advanced communications, as we believe this will provide additional benefits (not quantified in this study).. The additional costs of allowing for daily reading as against the current quarterly or monthly reading cycles are therefore included in section 3, and a discussion of the benefits that could accrue from daily data is to be found in section 4. It is noted that the capability for daily reading does not imply that MDPs need to read all meters daily (and hence do validation and substitution for all meters daily) or that Retailers must accept daily data on all meters. Rather meters may be read as infrequently as required, but the capability is there to do daily reading if required.
- We have allowed for remote connection and disconnection functionality. This then allows for the continuation of the practice common amongst some retailers where on a customer move out a disconnection is requested. This requires connect/disconnect contactors to be fitted in each meter and also requires an IT system to manage the connect / disconnect function. This is further discussed in section 2.1.4.

This platform is designed to be able to provide interval meter data on a daily basis in the same format (or a similar format) as the data would be provided with manually read interval meters under IMRO. Thus:

- In scenario 1, there should be no significant difference in the requirement for upstream IT systems for meter data above what is anyway required for IMRO. (There would be an additional requirement for a connect/disconnect IT system as noted above.)
- In scenario 2, the need to handle larger volumes of data would be brought forward, due to accelerated rollout of interval meters. We expect that the software systems being implemented for IMRO will be designed to cope with these volumes of data, which would be required anyway at some stage under IMRO. There may be requirements for additional storage capability to be available earlier to hold the additional data – this may not represent a material additional cost.<sup>5</sup>

This then becomes the platform for adding additional functionality and benefits, should that be desired. The functionality described here is robust in its own right without any further enhancement. Processes for agreeing additional functionality and benefits are discussed in section 6.

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<sup>5</sup> It has been estimated that additional storage may cost around \$500,000.

Although one-way communications systems can provide remote meter reading, they cannot provide remote connect and disconnect capability. Hence because one-way communications systems cannot meet these minimum functionality requirements only two-way communications systems have been considered in this study.

#### 2.1.4. Meter Specification

Our starting point for specifying a meter for this study was the IMRO meter specification. IMRO meters are electronic meters that collect and store up to 200 days of half-hourly interval data at the customer site. This type of meter is very different from the typical meter configuration that is used in all large-scale deployments of advanced metering in North America. In North America, the most common deployment involves retrofitting electro-mechanical meters with modules that record and communicate readings to concentrators at frequent intervals (every few minutes in many instances). In combination with upstream network intelligence that computes and records the data according to set time periods, a “dumb meter, smart system” configuration such as this can provide interval data for all customers. This approach is nearly universal in North America because it is the most cost-effective approach for mass deployment. Because it retrofits rather than replaces existing meters, this approach has the added advantage that there are minimal stranded costs to factor into the economic analysis. If deemed beneficial, individual customer data could be communicated back to each customer either using the same network being used for meter reading (assuming two-way communication), or through alternative channels such as the Internet.

The retrofit approach was considered but not analysed in detail in this study for several reasons. First, the space available under the cover of most installed meters in Australia is much less than is found in typical North American meters, which could make retrofitting modules more difficult. There also is a wider variety of meter configurations among the installed base in Australia, in terms of shapes and configuration of parts, which would make the design and manufacture of modules more expensive. Differences in meter standards and testing requirements in Australia could also make the retrofit option more costly than in North America. Finally, during the course of this study, we did not find any meter vendors that were willing to give us pricing for this option.

Furthermore, in all major implementations of advanced metering in Europe, retrofitting of electromechanical meters has not occurred. Instead, the old electromechanical meters have been replaced with electronic meters which have integrated communications devices.

In relation to meter standards we did, however, explore three departures from the current IMRO standards:

- Inclusion of connect/disconnect contactor;
- Removal of the mandatory battery, that is used in case of a power outage; and
- Reduction in the on-site storage capacity of the meter.

Each of these is discussed in turn below.

### *Connect/Disconnect Contactor*

The remote reading capability can be used to read meters on a routine basis and for special reads. However, special reads are often done in conjunction with de-energisation of the customer's premises on move-outs. Remote meter reading capability on its own would not then eliminate a visit to the customer's premises on a move-out. Two options were considered for dealing with this.

Option 1 – On customer move outs perform a final remote reading of the meter and then monitor consumption on a daily basis utilising an IT system to provide this capability. Should consumption occur after the final reading and a retailer has not been contracted for the property, a notice could be sent to the occupant of the property advising their liability for the cost they have incurred so far and the requirement for them to nominate a retailer. This would then reduce the “unknown customer” cost to retailers (although some retailers were concerned there would still be debt write-offs). In our analysis the net present cost of this approach (including IT costs) is about \$50m.

Option 2 – Add a remote connect/disconnect contactor in all meters so that on customer move outs a remote final read followed by a remote disconnection could occur. On customer move-in and appointment of retailer a remote connection “arming” command can be sent to the meter. This then enables the customer to press a button on the meter to cause the contactor to close and connect supply again. The net present cost for this option is about \$72m. Although there is a higher cost with this option it has been adopted for this study due to the additional benefits (not quantified in this study) it provides:

- It allows a larger range of tariff options for retailers into the future that may include debit based tariffs
- It allows the facility for better targeted load shedding in times of power system stress or when demand exceeds supply. At present such load shedding happens at a transmission terminal station level and blacks out large areas totally. With a more targeted approach it may be possible to maintain supply to essential services such as traffic lights, medical and emergency services facilities (eg; Police, Fire Ambulance etc).

### *Batteries*

Manually read interval meters require a battery to maintain the real time clock during power outages, in order to be able to record energy consumption correctly in the appropriate half hour intervals immediately when power is restored.

We considered that with advanced communications the real time clock in the meter can be reset immediately after a power failure, hence not requiring a battery. In North America, most installations with remote communications, including the planned implementation of some 5 million electric meters by PG&E in Northern California, do not include batteries in the specification.

Therefore, for all technologies we have specified a meter without a battery. Excluding the meter battery could save about \$3 per meter. More importantly, with a rated battery life of only 10 years (but an actual life of perhaps 15 years), an expensive battery replacement program would need to be implemented starting 10 years after meter installation for the IMRO meters with batteries. This cost saving is discussed further as a benefit in section 4 below. Our main reason for proposing that meters without batteries be used is to eliminate battery replacement rather than to enable a slightly cheaper meter to be purchased, the former representing a more material saving than the latter.

### *Storage Capacity*

IMRO meter standards require storage capacity for 200 days worth of interval data. This is a reasonable standard when meters are read quarterly. However, with communications functionality, meters will likely be read much more frequently, perhaps daily, and, as discussed above, in our model we have allowed for daily reading of meters with advanced communications. Thus, there may no need for the large storage capability, and the metrology requirement for a meter that is read daily is that it is only required to have 35 days' storage capacity.

Notwithstanding, we did not wish to preclude in this study the possibility that market participants may not want to increase the data reading frequency. Thus our pricing is based on retaining the meter storage capability of holding 200 days of data. This does not remove the possibility that in the future with advanced communications the meters could be read more frequently and consequentially be designed with less storage. We note, however, that our initial discussions with manufacturers suggested that as memory is not expensive there might be no significant price reduction for a meter with less storage.

### **2.1.5. Starting Dates for Rollout of Advanced Communications**

The IMRO decision requires some elements of rollout of interval meters without communications to commence in January 2006, which is in less than two months' time. Scenario 1 in this study evaluates the benefits and costs of rolling out advanced communications alongside the IMRO meters, and scenario 2 evaluates an accelerated rollout.

It is now unrealistic to expect that an advanced communications rollout can be designed and implemented to commence in January 2006. Therefore, for the purposes of estimating benefits and costs in this study, we have assumed that rollout of interval meters with advanced communications would be deferred to begin in 2009. In the case of scenario 2, the accelerated rollout would occur over a four-year period. The four year period is selected as an indicative accelerated rollout period for the purposes assessing the impact of acceleration on net benefits. This is not to say that four years is the optimal rollout period, indeed a shorter or longer time may prove to be optimal.

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The primary reason to conducting the analysis with a start date of 2009 for rapid deployment was advice received from the ESC that there would be a labour shortage that could inhibit accelerated deployment of new meters prior to that date. A 2009 start date would also allow more than sufficient time to resolve the many important issues and implement a variety of useful activities, including:

- Making of the necessary policy and business decisions for a rollout to proceed;
- Running trials of systems;
- Technology choices;
- Functionality specification;
- Tendering and awarding of contracts with vendors;
- Equipment design, manufacture and delivery;
- Installation of new meters; and
- Building of a communications network (if a private network is to be used).

However, we are confident that the majority of these activities could be completed in 12 to 18 months, so that implementation could commence prior to 2009 if the skilled labour shortage issue could be resolved.

The advanced communications rollout would include communications modules integrated in the same box as the meter. Therefore, additional costs will be incurred changing IMRO meters to meters with advanced communications, if the IMRO program proceeds with large-scale rollout of interval meters that are manually read (i.e. rollout of meters beyond new/replacement only), before the industry is ready to rollout interval meters with advanced communications. These additional costs have not been included in this analysis, as they can be avoided if the implementation of rollout of IMRO meters is delayed until a program of rollout of interval meters with advanced communications can commence. If a rollout of new interval meters with integrated communications is to occur in the next few years, then it would seem appropriate for the ESC to consider deferring IMRO such that it does not commence in January 2006. If IMRO is delayed, then in the meantime the distributors would only be required to install new and replacement meters as usual, and in the below 160 MWh per annum market these could be accumulation or interval meters according to each distributor's individual preference.

Table 2 below summarises the differences between IMRO (our base case) and scenarios 1 and 2 in this study.

**Table 2: Summary of Differences between IMRO, Scenario 1 and Scenario 2**

Meter Type	Deployment Strategy	IMRO	Scenario 1	Scenario 2
		No Comms	Comms	Comms
Customers using above 160 MWh per year	New / Replacement Commence	January 2006	Not included in this analysis, and no change to IMRO is suggested	
	All Installed By	December 2007		
Customers using between 20 MWh and 160 MWh per year with off-peak metering or three-phase metering	New / Replacement Commence	January 2006	January 2009	January 2009
	All Installed By	December 2010	December 2013	December 2012
Customers below 20 MWh per year with off-peak metering or three-phase metering	New / Replacement Commence	January 2006	January 2009	January 2009
	All Installed By	December 2012	December 2015	December 2012
All customers with single-phase, non-off-peak metering	New / Replacement Commence	January 2008	January 2009	January 2009
	All Installed By	-	-	December 2012

In our model we consider the effects of three primary differences between IMRO and each scenario: deployment deferral and adding communications (scenario 1), and, in addition, deployment acceleration (scenario 2). Each of these has an effect on the benefit-cost analysis.

The key differences between IMRO and scenario 1 are deferral of the rollout, and addition of advanced communications. The only difference between scenario 1 and scenario 2 is the acceleration of rollout once it has commenced.

#### 2.1.6. Use of Net Present Value

Because benefits and costs are achieved or incurred in different timeframes, we calculated the Net Present Value (NPV) of all benefits and costs in \$2005, in order to allow for meaningful comparisons to be made. Our analysis of benefits and costs stretches to the year 2027, and we used a discount rate of 6.50 per cent.

When choosing an appropriate discount rate, it is important to be consistent with how the cash flows are presented. One of the key issues is the treatment of tax. The respective values of the different WACCs arising from the EDPR Final Decision<sup>6</sup> are:

- Real post-tax vanilla WACC: 5.90%;
- Real post-tax WACC: 5.16%;
- Nominal post-tax WACC: 7.32%;
- Real pre-tax WACC: 6.50%; and
- Nominal pre-tax WACC: 9.32%.

The real post-tax “vanilla” WACC of 5.90 per cent used by the ESC shifts the tax allowance from the WACC to the cash flows. Depending on how the benefits are presented, in a cost benefit analysis such as this a more traditional pre-tax WACC is more appropriate. The real pre-tax WACC of 6.50 per cent is the most appropriate to use in this analysis.

### 2.1.7. Analytical Approach to Costs

The incremental costs vary across scenarios for several reasons.

Within scenario 1, scenarios 1a and 1b have the same number of meters requiring communications functionality, but both the capital and operating costs are quite different because of differences in the communication channel. Scenario 1a uses the public communications network while scenario 1b uses a combination of private and public networks. The cost of the private network varies with the technology assumed, and differs across distribution networks, as density and other considerations can cause technology choice and, therefore, costs to vary.

Scenario 2 accelerates the installation of interval meters and communications, relative to scenario 1. Thus, total costs are higher, although the average cost for some cost categories is lower, as fixed costs are amortised over more meters. Costs are also higher because the accelerated deployment moves these costs closer to the present day, thus increasing costs in present value terms. Within scenario 2, scenarios 2a, 2b, 2c and 2d each deploy the same number of interval meters with communications.

Incremental costs fall into the following categories, each of which is discussed further in section 3:

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<sup>6</sup> EDPR Final Decision, p.332

### *Costs of Meters with End-Point Communication Modules*

For IMRO, the meters being supplied do not include communications modules. In this study, we have obtained costs for meters with end-use communications modules instead. As discussed in more detail in the next section, in most cases it is cost-effective for the end-use communications to be integrated in the same box with the meter.<sup>7</sup> Meter costs differ from the IMRO costs and/or vary across scenarios for several reasons:

- Average costs of single phase meters are lower in scenario 2 than under IMRO or in scenario 1, because more meters are being purchased, and therefore meter manufacturers can pass on lower unit costs to the industry. Total costs will be higher in scenario 2 than under IMRO, because of the accelerated deployment. That is, there are more meters installed over the forecast horizon in scenario 2 than there are under IMRO, and many of the meters are installed sooner than they would be under the IMRO plan.
- End-point communication modules are being added to the meter in order to communicate with a public or private network.
- In scenarios 1b, 2b, 2c and 2d, on a per-meter basis, the basic meter cost may also fall a little relative to an IMRO meter, as the meter specification does not include a battery.

Thus, depending on the deployment/technology combination, the average cost of a communicating meter in scenario 1 or scenario 2 could be higher or lower than the average cost of an IMRO meter under the IMRO deployment schedule.

### *Meter Installation Costs*

On a like-for-like basis, it costs the same to install a meter with communications as a meter without communications. However, the total installation costs differ between scenarios, and differ from the total IMRO installation costs, for a range of reasons. It is noted that for the technologies considered there is no additional cost for commissioning the meter communications. Meters with communications, when installed and initialised are recognised by the network infrastructure and no further action is required to ensure the required communications and meter functionality are operational.

### *Project Management Costs*

While all deployments will incur project management costs, our concern was only to identify the project management costs that are incremental to the costs that would be incurred under the IMRO deployment schedule. These have been identified as follows:

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<sup>7</sup> An exception is that scenarios 2b and 2c make use of PLC in relation to a small number of meters in remote areas. The small numbers of meters make it uneconomical to design a special meter with the PLC communications module in the same box, so in this case our cost analysis is based on the PLC communications module being in a separate box alongside the meter installation.

- There are additional project management costs for managing the greater complexities of a project involving advanced communications rollout, as against the simpler IMRO rollout without remote communications.
- For scenario 2, the project management costs also take into account the substantially larger program of rollout than is included under IMRO or under scenario 1.
- Scenarios 1a and 2a (and to a lesser extent scenario 2b) have some additional project management requirements to cover the replacement of GPRS and CDMA at year 10.

Details of the allowances that have been made for additional project management can be found in section 3.6.

#### *Private Network Capital Costs*

These costs apply to all scenarios except 1a and 2a, since scenarios 1a and 2a use only a public network communication channel.

#### *Private Network Operating Costs*

These are the costs of operating and maintaining a private network in all scenarios except 1a and 2a – specifically in relation to the repair and replacement of DLC data concentrators, mesh radio meter collectors, and PLC transceivers.

#### *Public Network Communication Costs*

For scenarios 1a and 2a (and to a small extent 1b in relation to communications for remote rural areas), these costs cover the payments to the public network service provider for use of the network for communications to each meter.

For all scenarios involving technologies b, c, and d, public network communication costs cover the cost for public phone network connections to the DLC data concentrators, mesh radio meter collectors or PLC transceivers, across which data for multiple end points is sent to meter data management agents.

#### *Incremental IT Capital Costs*

All advanced communications rollout scenarios will involve additional costs for the provision of a network management system and a connect/disconnect system. Distributors and retailers are already investing in new IT systems in order to use interval data from the IMRO meters, so there are no other incremental IT capital costs in scenario 1.

In scenario 2, the need to handle larger volumes of data would be brought forward, due to accelerated rollout of interval meters. We expect that the software systems being implemented for IMRO will be designed to cope with these volumes of data, which would be required anyway at some stage under IMRO. There may be requirements for additional storage capability to be available earlier to hold the additional data – this does not represent a material additional cost.

#### *Incremental IT Operating Costs*

Incremental IT operating costs relate to the new network management systems, referenced above. The associated costs will cover operating these systems, as well as additional costs of any ongoing incremental hardware maintenance and software licensing.

### **2.1.8. Analytical Approach to Benefits**

Benefits also vary across scenarios, for similar reasons. The largest benefit derives from avoided cost of both regular and special reads.

There are a variety of potential benefits associated with communications functionality, not all of which are easily quantified. The benefits that have been quantified and included in this analysis, each of which is discussed further in section 4, are as follows:

#### *Avoided Cost of Regular Meter Reads*

The largest single benefit is the avoided cost of manual meter reads. In the sub 160 MWh category, most meters are generally read quarterly in Victoria.<sup>8</sup> The cost of reading IMRO meters manually is higher than the cost of reading accumulation meters.

- In scenario 1, benefits accrue from the avoided cost of reading IMRO meters, as these will now be read using remote communications capabilities.
- In scenario 2, there are avoided costs from manual reading of all meters – accumulation meters and interval meters.

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<sup>8</sup> The percentage of customers read monthly appears to vary between 1% and 7% across distribution businesses. These exceptions do not materially change the analysis.

With the elimination of manual reading of meters some have expressed concern that there would be an increase in tampering or damage to meters. It is our opinion that the implementation of advanced interval metering with communications would not increase meter tampering or damage, but rather it has the capacity to reduce tampering and meter damage. Many of the newer electronic meters have quite sophisticated tamper detection capabilities. This can include detection of any bypassing of the meter, and any unauthorised opening of the meter. With remote communications capability any tampering detected can be immediately alarmed. Further if a meter has been disabled then the absence of communications to and from the meter will detect this.

#### *Avoided Costs of Special Meter Reads*

Special reads and de-energisations (and later re-energisations) are frequently undertaken upon change in occupancy and are costly to undertake. This is a significant cost for many retailers that can be significantly reduced or eliminated with advanced communications rollout.

#### *Reduced Portable Data Entry Costs*

Meter readers require Portable Data Entry (PDE) devices in order to download interval data from IMRO meters at the meter site. With advanced communications, these devices would not need to be purchased or maintained.

#### *Avoided Battery Replacement*

Battery manufacturers only guarantee the life of batteries within electricity meters for 10 years. Therefore, where meters with batteries are used, as in the case of IMRO, there is need for a battery replacement program to commence ten years after these meters start to be rolled out. In this study, scenarios 1b, 2b and 2c and 2d specify meters without batteries, and therefore in these scenarios there is a saving from this replacement program being avoided. In scenarios 1a and 2a, we have made provision for the meters to be replaced before the batteries would need to be replaced, so here also there is a benefit from the avoidance of a battery replacement program.

#### *Call Centre Cost Reductions*

A large proportion of calls to retailers' call centres relate to estimated bills, delayed bills and meter access /meter reader issues. This is a significant cost that can be significantly reduced with advanced communications.

#### *Demand Response*

Reducing peak demand, and thereby reducing the need for new generation, transmission and distribution capacity, was one of the primary motivations for the IMRO policy. IMRO meters support a wide variety of pricing options designed to reduce peak demand.

The extent to which adding communications capabilities to IMRO in either scenario 1 or scenario 2 will give enhanced demand response (DR) has been a matter for some debate during the course of conducting this study.

In scenario 1, adding communications to IMRO meters does not necessarily produce incremental DR benefits, since time-varying pricing can be supported with manually read IMRO meters, albeit with significantly delayed billing, which, some have argued, may diminish demand response. Thus, the pricing options available with and without communications functionality are largely the same. Adding communications may give enhanced demand response for IMRO customers through the use of enabling technology – smart thermostats, in-home notification devices, direct load control devices, etc. However, using the meter communication channel for these devices may not be the least cost option, and there are certainly methods of providing this capability in the absence of advanced meter communications.

In order to be conservative, we have therefore not included any estimates of incremental benefits for enhanced load management in scenarios 1a and 1b. In fact, we have allowed for reduced benefits from DR in scenario 1 as compared to IMRO – due to deferment of the IMRO program in scenario 1.

Under scenario 2, many more interval meters are installed over the forecast horizon, and the incremental benefit associated with these meters is estimated in this study.

### *Other*

It is our view that there are many other quantifiable benefits that will almost certainly accrue from full scale deployment of advanced metering that we were not able to quantify due to lack of information from stakeholders and the relatively high-level nature of the project (compared with the “drill-down” that occurs when company-specific business cases are completed). These other quantifiable benefits include better outage detection, load management, distribution transformer monitoring, LV network monitoring & control, street light monitoring and control, reductions in rebilling, and elimination of profiling for settlement. It is noted that among the distributors and retailers involved in this study there were diverse views on the quantum of these other benefits. Typical business case analysis projects in North America have found that quantifiable benefits such as these can amount to 100 to 300 percent of the savings associated with elimination of normal meter reads. In addition, there are many non-quantifiable benefits that may also accrue, such as faster and more accurate settlement, improved customer satisfaction, and product/service innovation. We are confident that a more thorough investigation of benefits would substantially improve the already attractive net benefit estimates reported here.

## **2.2. APPROACH TO DATA GATHERING**

### **2.2.1. Research to Obtain New Cost Information**

A significant effort was undertaken to develop reasonable estimates of incremental costs for meters with communication modules, and other associated cost items. A Request for Information (RFI) was used to gather cost information from distributors, retailers, Metering Data Agents (MDAs), external vendors and other stakeholders in Australia in a formal and structured manner, and RFIs were also sent to retailers and distributors regarding operational benefits that might be achieved through advanced communications rollout. Several workshops and numerous one-on-one meetings were held, to discuss the information needs of the project, and to understand the information that was provided by various stakeholders. We also spoke with vendors in North America, Europe and Asia. Copies of the RFIs and slides from our workshop presentations were also made available on the Department of Infrastructure's website. A listing of the organisations to which the RFIs were sent, and the organisations from which responses were received are contained in Appendices to this report. The information obtained through this process was much appreciated and carefully considered as input to our analysis.

The communications and metering cost information gathered via the RFI process has also been tempered with experience, engineering judgment and common sense. Because the responses to the RFI are not binding in any way and were issued by a party that does not represent the potential buyers of the new metering systems, care was taken to filter the information received and validate it against information from other sources. Vendors that may be motivated to help create the market for communications in Victoria may quite naturally tend to be optimistic in the pricing they submit to avoid discouraging policy makers. Conversely, vendors that are not convinced that the project is a real opportunity or stakeholders that may want to discourage the policy for whatever reason may quite naturally be reluctant to reveal their "best" pricing and may be pessimistic in the preparation of their responses. In addition, although providing quite attractive pricing, some vendor responses appear not to have appreciated the significance of the differences in metering standards in Australia compared to other parts of the world. As a result, the information we obtained showed a range in incremental costs from costs that were significantly less than IMRO meter costs to costs that were significantly greater.

Several steps have been taken to validate the cost information received:

1. Detailed discussions with individual vendors to obtain validation of pricing that seemed significantly low or high. In some cases vendors were able to validate their pricing against pricing they had offered in firm proposals to utility clients. In other cases, relatively low communications equipment costs were validated by discussion with the vendors of the key components for the communications functionality.
2. Third party validation of costs. For example, GPRS and CDMA communications charges have been validated by detailed discussions with a variety of MDAs. Communications equipment costs have also been validated by discussion with third party communications systems providers.

3. Comparison with European and North American pricing for similar communications equipment. In Europe there are roughly 35 million communicating electricity endpoints, and in North America roughly 20 million communicating electricity endpoints. European and Asian prices for IEC style meters with integrated DLC or GPRS communications devices were lower (for DLC significantly lower) than the prices given in responses to the RFI.
4. Using the manufacturing and engineering expertise of the team to understand what the product costs might be for adding communications to the meters. We understand these manufacturing costs well, and can use them to provide a sanity check on delivered prices, assuming a competitive bid process for the business. While vendors generally do not “cost-plus” price communications equipment, if the bid process turns out to be reasonably competitive, then the cost-plus pricing may give an approximate check on what final communications prices might be.

In summary, we started with the extensive information that was provided to us by local stakeholders. We have then applied the above validation processes to this information to select estimates that we believe are reasonably close to what might be obtained if advanced meter communications were to be rolled out in Victoria.

Finally, we have undertaken sensitivity analysis to determine how the net benefit estimates vary as the assumed costs vary.

### 2.2.2. Use of EDPR Final Decision

Given that we are considering scenarios relative to IMRO, we needed a baseline of costs and benefits for IMRO against which to assess incremental costs and benefits. Where relevant we have used information and data contained in the ESC’s recently released EDPR Final Decision<sup>9</sup> to create this baseline. Areas where we have used the EDPR Final Decision in our baseline against which to assess incremental benefits and costs include:

- Costs of the IMRO programme, including meter purchase and installation costs, back office costs, and customer service costs.
- Numbers of residential and business customers now, and projected growth in each for the next 5 years, for each distributor.
- Numbers of meters of the different types to be deployed each year under IMRO.
- Meter reading costs.

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<sup>9</sup> *Electricity Distribution Price Review 2006-10 Final Decision*, ESC, October 2005



### 2.2.3. Other Data Sources

We obtained geo-coded data file of every address in Victoria. We used this to establish where mesh radio would be a viable technological solution, and to validate some of our other results regarding applicable technologies. We have also used the publicly available Distributors Network Planning reports for information on numbers and locations of substations and distribution transformers.

### 3. COST ASSUMPTIONS

This section documents the input data and assumptions that were used to estimate incremental costs in this study. A key driver of costs (and benefits) is the number of meters by type that are installed for each scenario. This section therefore also documents the assumptions in this study with regard to meter stocks and deployment schedules.

#### 3.1. BASE YEAR METER STOCKS

The analysis of benefits and costs requires base year and deployment estimates for meters by meter type and customer type. Meter type is important because purchase and installation costs vary by meter type. Customer type is important because the number of meter reads varies by customer type (generally quarterly for residential customers and monthly for business customers). Demand response estimates also vary by customer type. Unfortunately, we were not able to find an information source that contained meter numbers by meter type and customer type that was consistent with overall customer numbers. Thus, assumptions were required, as summarised below.

Templates published by the ESC with the EDPR Final Decision contain estimates of the number of customers that have each of the four primary meter types:

- 1 phase non-off-peak meters: single register meters for whole premise loads with single-phase supply;
- 1 phase off-peak: meters for premises with single-phase supply, which contain two registers, one for a dedicated circuit for off-peak water or space heating, and the other for the rest of the premise (or alternatively two physical meters may be installed). These installations also include, either as part of the meter or as a separate device, a timeswitch with an integral contactor on the dedicated circuit, so that the dedicated circuit is only energised at those times when the off-peak tariff applies;
- 3 phase direct connected: meters used for some large households and for small to medium businesses with three-phase supply where the meter is directly connected in series with the load; and
- 3 phase CT connected: accumulation meters for large businesses with three-phase supply, where the meter is connected with current transformers to measure the energy usage at the premise.

There were small discrepancies between the total number of customers contained in these templates and the total number of customers reported in Table 4.2 of the EDPR Final Decision. We therefore adjusted the template values by meter type by multiplying each value by the ratio of total customers in the EDPR Final Decision to total customers in the template.

Table 3 shows the meter stock estimates for each distributor used in our model.

**Table 3: 2005 Meter Stocks**

Distributor	Customer Segment	1 Phase Non-off-peak	1 Phase Off-Peak	3 Phase Direct Connected	3 Phase CT Connected	Total
<b>AGLE</b>	<b>Residential</b>	217,106	35,698	3,844	0	256,649
	<b>Business</b>	3,049	3,049	21,785	1,887	29,771
	<b>Total</b>	220,156	38,748	25,629	1,887	286,420
<b>CitiPower</b>	<b>Residential</b>	179,157	31,251	24,304	0	234,712
	<b>Business</b>	11,578	7,719	24,304	3,092	46,693
	<b>Total</b>	190,735	38,970	48,608	3,092	281,405
<b>Powercor</b>	<b>Residential</b>	292,793	195,595	49,866	0	538,254
	<b>Business</b>	23,179	23,179	49,866	4,905	101,129
	<b>Total</b>	315,972	218,774	99,732	4,905	639,383
<b>SP AusNet</b>	<b>Residential</b>	233,055	232,491	31,309	0	496,855
	<b>Business</b>	15,340	23,009	31,309	1,122	70,780
	<b>Total</b>	248,395	255,501	62,617	1,122	567,635
<b>United</b>	<b>Residential</b>	389,571	125,454	33,389	0	548,414
	<b>Business</b>	12,748	12,748	33,389	2,541	61,425
	<b>Total</b>	402,318	138,202	66,778	2,541	609,839
<b>Total</b>	<b>Residential</b>	<b>1,311,682</b>	<b>620,489</b>	<b>142,712</b>	<b>0</b>	<b>2,074,884</b>
	<b>Business</b>	<b>65,894</b>	<b>69,704</b>	<b>160,653</b>	<b>13,547</b>	<b>309,798</b>
	<b>Total</b>	<b>1,377,576</b>	<b>690,195</b>	<b>303,364</b>	<b>13,547</b>	<b>2,384,682</b>

### 3.2. CHANGE IN METER STOCK OVER TIME

The change in the stock of meters over time is also a key driver of costs and benefits. The number of meters by type each year, and the additions to the stock of meters each year, are a function of the following factors:

- Population growth by type of customer;
- The annual rate for replacement of meters in the field (due to meters being faulty or no longer being compliant with appropriate codes);
- The IMRO deployment schedule;
- The deferred IMRO deployment schedule in scenario 1; and
- The deferred and accelerated deployment schedule in scenario 2.

### 3.2.1. Population Growth Rates

Population growth rates were taken from Table 4.2 of the EDPR Final Decision. The estimates, shown in Table 4, equal the compound annual growth rate estimated to occur between 2004 and 2010. We extended these growth rates through to the end of the forecast period, 2027.

**Table 4: Population Growth Rates (%)**

Customer Segment	AGLE	CitiPower	Powercor	SP AusNet	United
Residential	1.45	2.21	1.40	2.58	0.81
Business	0.49	0.83	2.14	2.70	1.70

### 3.2.2. Meter Replacement Rates

#### *Meter Failures*

The annual rate for replacement of failed meters is based on information contained in the ECG report, *Review of Costs for the Interval Metering Rollout*.<sup>10</sup> Graph 4-8 of that report shows replacement rates between 0.8 percent and 1.1 percent for all distributors except United, which estimates only a 0.4 percent replacement rate. The ECG report states, “that the range of 0.8% to 1.1% per annum would be within the level of variation for estimating the replacement of volumes.”

For simplicity, for all distributors, we used the following replacement rates:

- 1% for existing non-interval meters;
- 1% for interval meters without communications in the IMRO base case;
- 1.5% for interval meters with communications in scenarios 1 and 2, to reflect that these may have a higher incidence of failure than meters without communications.

It is our view that these failure rates are appropriate for the private network options as their modems are of simple design and construction; however it understates the failure rates for public network modems. MDAs report failure rates of 3% and greater for GSM modems used on type 4 metering.

#### *Replacement of Aged Meters*

Existing non interval meters have a life of 40 years, which is modelled as a 2.5% annual replacement factor on the basis of meter age. New interval meters are taken in the analysis to have an average life of 14.5 years, which is slightly less than the 15 years assumed in the IMRO analysis.

<sup>10</sup> Energy Consulting Group. *Review of Costs for the Interval Metering Rollout*, 1 June 2005, pp. 15 and 16

### 3.2.3. Deployment Schedules

Meter deployment estimates under the IMRO schedule for the years 2006 to 2010 were based on the tables on pages 557-564 of the EDPR Final Decision, and extrapolated beyond 2010 to meet the requirements of the IMRO schedule.

Table 5 below summarises the differences between IMRO (our base case) and scenarios 1 and 2 in this study.

**Table 5: Summary of Differences between IMRO, Scenario 1 and Scenario 2**

Meter Type	Deployment Strategy	IMRO	Scenario 1	Scenario 2
		No Comms	Comms	Comms
Customers using above 160 MWh per year	New / Replacement Commence	January 2006	Not included in this analysis, and no change to IMRO is suggested	
	All Installed By	December 2007		
Customers using between 20 MWh and 160 MWh per year with off-peak metering or three-phase metering	New / Replacement Commence	January 2006	January 2009	January 2009
	All Installed By	December 2010	December 2013	December 2012
Customers below 20 MWh per year with off-peak metering or three-phase metering	New / Replacement Commence	January 2006	January 2009	January 2009
	All Installed By	December 2012	December 2015	December 2012
All customers with single-phase, non-off-peak metering	New / Replacement Commence	January 2008	January 2009	January 2009
	All Installed By	-	-	December 2012

The key differences between IMRO and scenario 1 are deferral of the rollout, and addition of advanced communications. The only difference between scenario 1 and scenario 2 is the acceleration of rollout once it has commenced.

### 3.3. COSTS OF IMRO METERS (MANUALLY READ)

For IMRO, the meters being supplied do not include communications modules. The costs for IMRO meters were taken from the EDPR Final Decision<sup>11</sup>. The cost for any given meter type varies by distributor, as shown in Table 6 below. These costs include a 5% mark-up to cover logistics and disposal costs in the AGLÉ, CitiPower and United Energy distribution areas, and a further mark-up of 1.5% in the Powercor and SP AusNet areas (except in the case of 1 phase off peak interval meters, where the mark up from AGLÉ, CitiPower and United Energy to Powercor and SP AusNet is 8.5%, to allow for 1-element meters in the AGLÉ, CitiPower and United Energy areas, as against 2-element meters in the Powercor and SP AusNet areas).

Table 6 also shows a weighted average cost for each meter type, which is calculated based on weighting of the number of meters of each type in each distribution area. For simplicity, rather than calculating everything by individual distribution area, this weighted average cost is used in our model, and is used in all the tables in section 3.4 below.

All figures in Table 6 and in section 3.4 below are shown to the nearest \$, but in our model we carry exact amounts to allow for greater accuracy of calculations.

**Table 6: Meter Supply Costs – real \$2004**

Meter Type	Cost Without Logistics and Disposal	AGLE / CitiPower / United	Powercor / SP AusNet	Weighted Average IMRO Meter Supply Cost
Accumulation meter	\$35	\$36.75	\$37.30	\$37
1 phase non off peak interval	\$80	\$84.00	\$85.26	\$85
1 phase off peak interval	\$145	\$152.25	\$165.19	\$161
3 phase direct connected interval	\$295	\$309.75	\$314.40	\$312
3 phase CT connected interval	\$355	\$372.75	\$378.34	\$375

### 3.4. COSTS OF METERS WITH END-POINT COMMUNICATION MODULES

#### 3.4.1. Overview

In this study, we have obtained costs for meters with end-use communications modules.

<sup>11</sup> EDPR Final Decision, Table 13.13 on page 526

The costs we obtained were direct purchase costs from suppliers. For consistency to compare like with like, all the values in this section 3.4 have been marked up to allow for the logistics and disposal costs that have been identified in the EDPR Final Decision and which are included in the weighted average values shown in Table 6 above.

We sought to obtain prices from suppliers for meters with end-point communications modules for each of the eight roll-out and technology scenarios 1a, 1b, 1c, 1d, 2a, 2b, 2c, and 2d. However, we were unable to obtain costs for scenarios 1c and 1d, and therefore the only scenarios taken further in this report are scenarios 1a, 1b, 2a, 2b, 2c and 2d.

In some cases, the costs that we obtained for meters with end-use communications modules in this study were lower than the costs that were used in the EDPR Final Decision for meters without end-use communications. This has resulted in some negative incremental costs above IMRO, or some incremental costs that are positive, but smaller in magnitude than might have been expected. The reasons for these results are as follows:

#### *Single Phase Meters*

The volumes of single phase meters being deployed in scenario 2 are much greater than under IMRO or in scenario 1. These higher volumes allow for economies of scale and hence lower unit costs. Some of these economies of scale in single phase meters are also applicable to the 2-element single phase meters, even though the number of meters in that category being rolled out does not increase in scenario 2 as compared with IMRO or scenario 1. These volumes have attracted lower cost international scale players.

The incremental cost for DLC is lower than for other technologies. This is because, due to the rollout of interval meter communications that is taking place in other countries using this technology, the whole communications circuitry is now available on a single chip that is available from three suppliers at relatively low unit costs.

The inclusion of connect / disconnect contactors in single phase meters adds \$12.50 to the cost.

#### *Three Phase Meters*

The pricing of three phase meters appears to be falling internationally. Prices in Australia are also falling, but not so far to the levels found overseas. It would also appear that the pricing received on three phase meters has been to some extent influenced by the significant volumes of single phase meters.

The pricing received for three phase CT connected meters is in some instances markedly lower than that in IMRO or EDPR, and much closer to the prices for direct connected meters. It would appear that technology has allowed there to be less difference in cost between CT connected and direct connected meters.

The inclusion of connect / disconnect contactors in three phase direct meters adds \$40 to the cost. For CT connect meters, the cost is estimated at \$100.

### 3.4.2. IMRO Schedule with Wireless (GPRS or CDMA) Technology – Scenario 1a

Costs have been obtained for meters with plug-in GPRS or CDMA modems so as to have just one combined unit to install at customers' premises. Several manufacturers provided pricing on metering with GPRS or CDMA modems. The indicative incremental cost above the IMRO price for meters without communications and connect/disconnect contactors is shown in Table 7 below, for each meter type. For the purposes of modelling this option, indicative incremental costs were determined based on the range of prices offered and a qualitative assessment of the experience of the manufacturers with the types of meters.

**Table 7: Incremental Costs – Scenario 1a: IMRO Schedule with Wireless (GPRS or CDMA) Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$666	\$291
<b>3 Phase Direct Connect</b>	\$312	\$476	\$164
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$278	\$117
<b>1 Phase without Hot Water</b>	\$85	\$224	\$139

As noted above, allowance has been made to replace the plug-in modems in year 10. The indicative price for GPRS modems required for replacements in year 10 is \$137.

### 3.4.3. Accelerated Rollout with Wireless (GPRS or CDMA) Technology – Scenario 2a

The incremental costs for a rapid rollout using GPRS or CDMA are given in Table 8. The indicative incremental costs have been determined in the same way as for scenario 1a.

**Table 8: Incremental Costs – Scenario 2a: Accelerated Rollout with Wireless (GPRS or CDMA) Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$645	\$270
<b>3 Phase Direct Connect</b>	\$312	\$455	\$143
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$257	\$96
<b>1 Phase without Hot Water</b>	\$85	\$195	\$110

### 3.4.4. IMRO Schedule with Distribution Line Carrier (DLC) Technology – Scenario 1b

There have not been as many submissions for scenario 1 as for scenario 2 for DLC. Table 9 below summarises the pricing of meters with DLC communications included.

**Table 9: Incremental Costs – Scenario 1b: IMRO Schedule with Distribution Line Carrier (DLC) Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$402	\$27
<b>3 Phase Direct Connect</b>	\$312	\$339	\$27
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$204	\$43
<b>1 Phase without Hot Water</b>	\$85	\$124	\$39

The indicative incremental pricing used is based on using those prices for meters with DLC from manufacturers that have the most appropriate level of experience with the technology, but also have an appreciation of the metering standards in Australia.

For this scenario, rural areas use GPRS/CDMA communications. The incremental price is the cost of modems at \$130 plus the cost of disconnect relays.

### 3.4.5. Accelerated Rollout with Distribution Line Carrier (DLC) Technology – Scenario 2b

A range of meter manufacturers have provided pricing for interval meters with ANSI 709 communications integrated into the meter. One manufacturer submitted pricing for an IEC based DLC communications protocol, which appears to be significantly more costly than an ANSI 709 solution.

Table 10 below compares the indicative unit cost for each meter type with the IMRO prices.

For single-phase non off-peak meters with DLC, unofficial submissions were received indicating prices that were about 50% less than IMRO prices. Subsequent to this present study, it may be beneficial to investigate these meters further. For this present study, more conservative pricing was used for single-phase meters with known compliance to Australian Standards and metrology requirements.

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The indicative incremental pricing used is based on using those prices for meters with DLC from manufacturers that have the most appropriate level of experience with the technology, but also have an appreciation of the metering standards in Australia. It is again noted that some manufacturers are offering prices that are substantially below the IMRO prices, and there is opportunity for the industry to realise these lower prices subsequent to this study.

**Table 10: Incremental Costs – Scenario 2b: Accelerated Rollout with Distribution Line Carrier (DLC) Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$402	\$27
<b>3 Phase Direct Connect</b>	\$312	\$339	\$27
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$178	\$17
<b>1 Phase without Hot Water</b>	\$85	\$97	\$12

For this scenario, rural areas use PLC communications. Table 11 below compares the indicative unit cost for each meter type with the IMRO prices.

**Table 11: Incremental Costs – Scenario 2b: Accelerated Rollout with Power Line Carrier (PLC) Technology for Rural Areas**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$565	\$190
<b>3 Phase Direct Connect</b>	\$312	\$439	\$127
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$259	\$98
<b>1 Phase without Hot Water</b>	\$85	\$183	\$98

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### 3.4.6. Accelerated Rollout with Mesh Radio Technology – Scenario 2c

Three major meter manufacturers have provided pricing for meters with mesh radio communications. None of these manufacturers currently has a meter with a mesh radio device integrated in it that is compliant with Australian requirements. However, all of the suppliers have provided these prices on the basis of meters that would meet Australian requirements. The pricing is summarised in Table 12 below. This represents our view of incremental cost of the most suitable meters for each category, taking into account the experience of the manufacturers with volumes of meters of each type and their experience with Australian standards.

**Table 12: Incremental Costs – Scenario 2c: Accelerated Rollout with Mesh Radio Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
3 Phase CT Connect	\$375	\$600	\$225
3 Phase Direct Connect	\$312	\$350	\$38
1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control	\$161	\$233	\$72
1 Phase without Hot Water	\$85	\$128	\$43

For this scenario, rural areas use PLC communications. Table 13 below compares the indicative unit cost for each meter type with the IMRO prices. It is noted that the incremental costs for PLC in this scenario are a little lower than for scenario 2b (Table 11). This is due to the higher volume of meters with PLC required for rural areas with scenario 2c compared to scenario 2b.

**Table 13: Incremental Costs – Scenario 2c: Accelerated Rollout with Power Line Carrier (PLC) Technology for Rural Areas**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
3 Phase CT Connect	\$375	\$555	\$180
3 Phase Direct Connect	\$312	\$428	\$116
1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control	\$161	\$249	\$88
1 Phase without Hot Water	\$85	\$172	\$87

### 3.4.7. Handling of Remote Rural Customers in Scenarios 1b, 2b and 2c

In rural areas where customer densities are low, the DLC and mesh radio systems are not economic. This applies mainly in the Powercor and SP AusNet areas, but also to some extent in the United Energy area (around the Mornington Peninsula).

- The economics of DLC depend on the number of customer meters per distribution transformer and the distance of the customer meters from the transformer. We undertook a detailed analysis of numbers of customers per distribution transformer, and ended up using a threshold that is equivalent to 10 customers per transformer. Based on this, we estimate that it is not economic to use DLC for about 8% of customers in Victoria.
- Mesh radio does not provide a solution for rural areas where customer density is low. We have used a threshold for mesh radio of a minimum of 200 customers per square mile. Using this threshold, and applying this to a file of geo-coded data on locations of addresses that we obtained from Land Victoria, it was determined that mesh radio is unsuitable in respect of about 13% of customers in Victoria.

For these rural customers, the options are to use CDMA or PLC as the communications medium.

#### *Solution for Rural Areas for Scenario 1b*

For scenario 1b, our model is based on using GPRS/CDMA, due to the low number of meters involved. The cost of adding a GPRS/CDMA modem at each meter for these customers is \$120 per meter above the IMRO meter cost excluding logistics and disposal mark-ups, which comes to \$127 including these mark-ups.

#### *Solution for Rural Areas for Scenarios 2b and 2c*

One possibility is to communicate with these meters using CDMA as for scenario 1b. Another possibility is to use a PLC system that can communicate between the meters and the zone substations in the rural areas. We have chosen the PLC solution over the CDMA solution, for the following reasons:

- The overall cost is lower.
  - For PLC, the incremental capital cost of the communications module in the meter (above the IMRO meter cost) is \$80 per meter excluding logistics and disposal mark-ups, which comes to \$85 including these mark-ups. The cost of the PLC transceivers at \$8.3m amortised over the 8% of rural meters in scenario 2b gives an additional incremental capital cost of \$43 per meter<sup>12</sup>, making a total incremental capital cost of \$128 per meter. This compares with an incremental

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<sup>12</sup> The figure is lower when amortised over the higher number of rural meters (13% as against 8%) that are treated as rural in scenario 2c.

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capital cost for a CDMA modem of \$127 per meter (including logistics and disposal mark-ups).

- With CDMA there are then further annual communications charges of \$40 per meter per annum, whereas with PLC the annual charges for communications to sub-stations amount to \$8,720 – which evaluates to 4c per meter.
- CDMA is not guaranteed to be available for the next 20 years. Hence if we used CDMA we would need to make provision in our model for CDMA module replacement in year 10.
- Certainty of communications: Although CDMA covers most country areas, there are pockets where it may not be reliable. In contrast, PLC will work wherever there are power lines.

#### 3.4.8. Accelerated Rollout with Power Line Carrier (PLC) Technology – Scenario 2d

None of the meter manufacturers that responded to the RFI provided pricing for PLC (as distinct from DLC) systems, although some indicated a willingness to look at integrating PLC systems into their meters. An estimate was made based on a major PLC vendor's pricing of PLC modules designed to go into meters. It is noted that these are indicative costs only. The pricing is summarised in Table 14 below.

**Table 14: Incremental Costs – Scenario 2d: Accelerated Rollout with Power Line Carrier (PLC) Technology**

Meter Type	EDPR IMRO Average Unit Cost (\$)	Indicative Unit Cost (\$)	Indicative Incremental Unit Cost (\$)
<b>3 Phase CT Connect</b>	\$375	\$567	\$192
<b>3 Phase Direct Connect</b>	\$312	\$409	\$97
<b>1 Phase – Hot water (2 element) with 30A 240V contactor for hot-water control</b>	\$161	\$227	\$66
<b>1 Phase without Hot Water</b>	\$85	\$146	\$61

### 3.5. METER INSTALLATION COSTS

On a like-for-like basis, it costs the same to install a meter with communications as a meter without communications. However, the total installation costs differ between scenarios, and differ from the total IMRO installation costs, for the following reasons:

- Scenarios 1 and 2 defer the installation of meters in comparison with IMRO. Therefore in these scenarios, non-interval meters continue to be installed as new and replacement meters until interval meter roll-out with communications commences in 2009.

- We have assumed a higher rate of failure of meters in the case of interval meters with communications (1.5%) as against interval meters without communications (1%). Therefore, there are more replacements of meters with communications (in scenarios 1 and 2), as against IMRO.
- In scenario 2, there are incremental costs relative to both IMRO and scenario 1, because of the accelerated deployment. However, during the period of accelerated deployment, installation costs per meter are expected to be lower than for the IMRO schedule. Accelerated deployment over a short time period (four years) allows for a very efficient installation process, as installers can work on a neighbourhood-by-neighbourhood basis, minimising “drive-time” and other inefficiencies associated with a piecemeal deployment approach. There may also be savings because of economies that can be achieved in the areas of customer contact and back office operations.
- It is expected that GPRS and CDMA will be replaced as a communications technology during the time horizon of this study. Therefore, as a prudent measure, allowance has been made in our analysis for the replacement of all metering and communications using GPRS or CDMA, at year 10. Because scenario 1a uses GPRS or CDMA across the state, whereas scenario 1b uses CDMA only in rural areas, the total installation costs of scenario 1a are higher than the installation costs of scenario 1b. Similarly, the installation costs of scenario 2a are higher than the installation costs of scenarios 2b, 2c and 2d.

In order to model the incremental installation costs of each scenario relative to IMRO, it was necessary to calculate the total installation costs for IMRO deployment, and the total costs for each scenario, and then calculate the differences between them. Meter installation costs are based primarily on data from the EDPR Final Decision. The tables on pages 530 and 533 show the cost for a replacement meter. These values include labour (with some allowance for after hours working), travel time, “site” costs, and back office operations to support the installations. “Site” costs cover rewiring, meter board replacement and asbestos issues for replacement meters. Back office operation costs cover the internal costs of raising a service order required to replace a meter. These tables do not include the cost for customer service operations associated with replacement meter installations (these are the costs associated with making appointments, multiple visits, communications and dealing with customer complaints). These additional costs are shown in Table 13.29 on page 543 of the EDPR Final Decision. We have added these values to the replacement cost estimates contained on pages 530 and 533 in the EDPR Final Decision to arrive at the installation cost estimates for normal replacement contained in Table 15.

For example, for AGL 1 phase non-off-peak interval meters we added together:

- Installation costs: \$80 – from Table 13.16 on page 530;
- Back office functions: \$16 – from Table 13.17 on page 530;
- Site costs: \$19.70 – from Table 13.18 on page 533; and

- Customer service costs: \$15 – from Table 13.29 on page 543.

This totals \$130.70 for a normal replacement cost. A normal replacement is one where a non-interval meter is being replaced with an interval meter, and all the above cost components apply.

For new installations, we assume that the site costs would equal zero, as there is no need to address asbestos issues, replace meter boards or do rewiring in new installations. Thus, the new installation costs in Table 15 equal the normal replacement values minus site costs. For example, for AGLE 1 phase non-off-peak interval meters, this cost is \$130.70 minus \$19.70, which equals \$111.

In the case where an interval meter that is already installed fails and has to be replaced by another interval meter, the same new installation costs would also apply. This is because in this case the legacy issues such as asbestos treatment, board replacement and rewiring will have already been dealt with as part of the initial interval meter installation, and those costs therefore do not have to be incurred a second time.

A third type of meter replacement, which is only relevant to scenario 2, is replacement during the accelerated meter deployment years from 2009 to 2012. Accelerated deployment over a short time period (four years) allows for a more efficient installation process. For the meters installed during this period:

- Installers can work on a neighbourhood-by-neighbourhood basis, minimising “drive-time” and other inefficiencies associated with a piecemeal deployment approach. We have estimated that this saves 3 minutes of the installer’s time for each urban installation, and 5 minutes of the installer’s time for each rural installation. At \$80 per hour, this is a reduction of \$4 for each urban installation, and \$6.33 for each rural installation.
- We expect that procedures will be put in place so that there will not be a need to cut a separate service order for each meter nor to address customer service issues in the same manner as when meters are installed at a slower pace and in a more geographically dispersed pattern.<sup>13</sup> Thus, the installation cost for meters installed in this rapid deployment period would involve reduced back office costs and customer service costs, as compared to those that are included in the normal replacement values. Indeed, there are reasons to believe that such cost savings could be between \$10 and \$30 per meter. If true, these savings could reduce implementation costs in Scenario 2 by tens of millions of dollars. However, it is difficult to estimate these cost reductions in the absence of a formal RFP process. To be conservative no value has been placed on these reductions in the scenarios presented. We have examined the value of such savings in our sensitivity analysis reported in Section 5.

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<sup>13</sup> We believe it is reasonable to assume that a mass mailing would be made for customers whose meters will be replaced each week or month, for example, notifying them that this will occur and that there will be a brief, temporary outage of service during the period. In this manner, installation crews can sweep through neighbourhoods in an efficient manner.

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For example, for AGLE single phase non-off-peak interval meters, the estimate of \$126.70 contained in Table 15 for an accelerated replacement equals the \$130.70 cost of a normal replacement, minus \$4 for the 3 minutes reduction in drive time.

**Table 15: Installation Cost Estimates**

Distributor	Installation Type	1 Phase Non-off-peak	1 Phase Off-Peak	3 Phase Direct Connected	3 Phase CT Connected
AGLE	New	\$111.00	\$172.00	\$207.00	\$535.00
	Normal Replacement	\$130.70	\$191.70	\$226.70	\$554.70
	Accelerated Replacement	\$126.70	\$187.70	\$222.70	\$550.70
CitiPower	New	\$112.20	\$173.20	\$233.20	\$606.20
	Normal Replacement	\$131.90	\$192.90	\$252.90	\$625.90
	Accelerated Replacement	\$127.90	\$188.90	\$248.90	\$621.90
Powercor	New	\$117.60	\$178.60	\$224.60	\$557.60
	Normal Replacement	\$140.50	\$201.50	\$247.50	\$580.50
	Accelerated Replacement	\$133.83	\$194.83	\$240.83	\$573.83
SP AusNet	New	\$118.70	\$179.70	\$222.70	\$552.70
	Normal Replacement	\$141.60	\$202.60	\$245.60	\$575.60
	Accelerated Replacement	\$134.93	\$195.93	\$238.93	\$568.93
United	New	\$106.60	\$167.60	\$202.60	\$530.60
	Normal Replacement	\$126.30	\$187.30	\$222.30	\$550.30
	Accelerated Replacement	\$122.30	\$183.30	\$218.30	\$546.30

### 3.6. PROJECT MANAGEMENT COSTS

While all deployments will incur project management costs, our concern was only to identify the project management costs that are incremental to the costs that would be incurred under the IMRO deployment schedule. These have been identified as follows:

- There are additional project management costs for managing the greater complexities of a project involving advanced communications rollout, as against the simpler IMRO rollout without remote communications.
- For scenario 2, the project management costs also take into account the substantially larger program of rollout than is included under IMRO or under scenario 1.

- Scenarios 1a and 2a (and to a lesser extent scenario 2b) have some additional project management requirements to cover the replacement of GPRS and CDMA at year 10.

The cost of project management above and beyond that required for IMRO is estimated to be 2 FTEs per distribution business for 5 years for scenario 1 (nominally 2009 to 2013 inclusive), and 4 FTEs per distribution business for 4 years for scenario 2 (nominally 2009 to 2012 inclusive). Provision has also been made for the same level of project management resource again in year 10 for the replacement of meters using GPRS and CDMA in scenarios 1a and 2a, and a third of the level of project management resource for the replacement of the much smaller number of meters that use CDMA in scenario 1b.

### **3.7. PRIVATE NETWORK CAPITAL COSTS**

The primary capital costs associated with building a dedicated, private communications network are associated with the costs of the concentrators, collectors or transceivers that collect data from the end-point meters and transmit it via the public network to the central data repository. These costs apply to all scenarios except 1a and 2a, since scenarios 1a and 2a use only a public network communication channel to go straight from the meters to the central repository.

#### **3.7.1. DLC Data Concentrators – Scenarios 1b and 2b**

DLC data concentrator pricing ranged from \$333 to \$1000 each. The lower priced data concentrators were from a vendor with much larger scale rollout experience than the other vendors., and hence their pricing was used as a base. In addition to the cost of the concentrators, one must add the cost of a GPRS modem, a waterproof (IP65) enclosure, cabling and terminations, plus labour to install on either a pole mounted substation or a pad mounted substation. We estimate that the total additional cost per concentrator equals \$330. Thus, the total installed cost for each data concentrator for the DLC network is \$663. DLC data concentrators are required at 37,726 distribution transformers in Victoria. Thus, the total initial cost for data concentrators would equal roughly \$25m.<sup>14</sup>

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<sup>14</sup> The number of transformers is assumed in our model to increase each year with customer growth, and provision is made for a data concentrator at each new transformer as required.

### 3.7.2. Mesh Radio Meter Collectors – Scenario 2c

Meter collectors act as data concentrators for the mesh system. They are also meters, and hence can be installed at suitable customer premises to perform the dual function of metering and data concentration. Meter collectors can handle up to 1000 meters. In practice, it is not possible to achieve this as an average number when covering urban, metro and regional/rural towns. It has been assumed in our analysis that there are 400 meters per meter collector on average. Meter collector costs range from \$1300 to \$4000 per unit. The price from the vendor with most experience in this area was \$4000, so it is this figure that has been used in our cost model. There are 5260 meter collectors required to cover the number of meters to be read using the mesh radio technology.

### 3.7.3. PLC Transceivers – Scenario 2d and Scenarios 2b and 2c (Rural)

The PLC transceivers at zone substations are significantly larger than the data concentrators used for DLC. The level of energy required to inject a signal at a substation that can be detected at meters necessitates reasonably large power levels. Typically, the transceiver will be connected to the substation bus (or buses) via a transformer of rating between 100kVA and 500kVA. The signals coming back from meters are detected on feeder or bus CTs (protection or measurement). The sizing of the transceiver is related to the MVA rating of the substation and the number of bus sections. The installed cost of transceivers varies from \$58,800 for a single bus (single transformer) substation to about \$90,080 for a triple bus (normally three transformer) substation. These costs are based on prices from a major PLC communications provider.

#### *PLC Transceivers for Scenario 2d*

We calculated that there are currently 223 zone substations in Victoria.<sup>15</sup> We have estimated that 20% of these substations have 3 transformers, 70% have 2 transformers, and the remaining 10% have 1 transformer. The total cost of supplying and installing transceivers for these zone substations was estimated to be \$18m.

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<sup>15</sup> The number of zone substations is assumed in our model to increase each year with customer growth, and provision is made for a transceiver at each new zone substation as required.

### *PLC Transceivers for Rural Areas for Scenarios 2b and 2c*

For scenarios 2b and 2c, our model is based on using a PLC system that can communicate between meters and zone substations. Based on distribution businesses' planning reports, we ascertained that there are currently 109 substations in rural areas where PLC transceivers may be required.<sup>16</sup> In the absence of knowledge as to exactly which substations serve these 8% of customers (in scenario 2b) or 13% of customers (in scenario 2c), we have assumed that all 109 rural substations would require PLC transceivers – though in practice a smaller number may be required.

We have estimated that 80% of these substations have 2 transformers, and the remaining 20% have 1 transformer. The total cost of supplying and installing transceivers for these zone substations was estimated to be \$8.3m.

#### **3.7.4. Replacement of Modems in Year 10**

It is expected that GPRS and CDMA will be replaced as a communications technology during the time horizon of this study. Therefore, as a prudent measure, allowance has been made in our analysis for the replacement of communications modems using GPRS or CDMA, at year 10.

The DLC data concentrators, mesh radio meter collectors and PLC transceivers all communicate with network management systems via GPRS. Therefore, in each case it is assumed that the GPRS modems are replaced in year 10.<sup>17</sup>

Due to the relatively small number of PLC transceivers in our model (223+ in scenario 2d, and 109+ to cover rural areas in scenarios 2b and 2c), the costs of replacing modems in the transceivers in year 10 are not material and have not been included in our model.

#### **3.8. PRIVATE NETWORK OPERATING COSTS**

These are the costs of operating and maintaining a private network in all scenarios except 1a and 2a – specifically in relation to the repair and replacement of DLC data concentrators and mesh radio meter collectors, and repair and replacement of components of PLC transceivers.

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<sup>16</sup> The number of rural zone substations is assumed in our model to increase each year with customer growth, and provision is made for a transceiver at each new rural zone substation as required.

<sup>17</sup> GPRS is assumed at sub-stations rather than PSTN lines, because, even with this additional cost at year 10, GPRS is cheaper. Rental on a PSTN line is \$20-\$40 per month (\$240-\$480 per annum), whereas GPRS to sub-stations costs \$80 per annum. We note that there may be existing communications at sub-stations that could be used, but we took the view that this analysis should not rely on bandwidth on those existing communications being available for this purpose.

### 3.8.1. DLC – Scenarios 1b and 2b

For scenarios 1b and 2b, allowance has been made for network infrastructure maintenance, as follows:

- Repairs and/or replacement of failed DLC data concentrators at a rate of 1.5% per annum (based on advice from a large scale provider of these units). Total annual opex of \$0.2m.
- Repairs and/or replacement of failed components of PLC transceivers in rural areas, at a rate of 5% per annum (based on advice from a large scale provider of these units). Total annual opex of \$0.03m.

### 3.8.2. Mesh Radio – Scenario 2c

For scenario 2c, allowance has been made for:

- Repairs and/or replacement of failed mesh radio meter collectors at a rate of 3% per annum (based on advice from a large scale provider of these units). Total annual opex of \$0.6m.
- Repairs and/or replacement of failed components of PLC transceivers in rural areas at a rate of 5% per annum (based on advice from a large scale provider of these units). Total annual opex of \$0.03m.

### 3.8.3. PLC – Scenario 2d

For scenario 2d, allowance has been made for repairs and/or replacement of failed components of PLC transceivers at a rate of 5% per annum (based on advice from a large scale provider of these units). Total annual opex of \$0.06m.

## 3.9. PUBLIC NETWORK COMMUNICATION COSTS

In our analysis, these costs are wireless network usage charges.

For scenarios 1a and 2a (and to a lesser extent 1b in relation to communications for remote rural areas), these costs cover the payments to the public network service provider for use of the network for communications to each meter. For all scenarios involving technologies b, c, and d, public network communication costs cover the cost for public phone network connections to the concentrators, across which data for multiple end points is sent to network management systems.

### **3.9.1. Wireless (GPRS or CDMA) – Scenarios 1a and 2a**

Several communications carriers made submissions against the RFI. Some carriers engaged in detailed discussions to achieve lower communications costs. The annual per meter GPRS prices quoted for reading meters ranged from lower end values of \$3.07 (assuming a state-wide scale for reading) & \$5.07 (assuming coverage of one distribution business) to \$120. The lower end of the cost range for daily reading was validated with Metering Data Agents, some of who are paying similar charges at present. Therefore for scenarios 1a and 2a, we are using a figure of \$5.07 per annum in our model,

### **3.9.2. Accelerated Rollout with DLC (Rural Areas) – Scenario 1b**

Based on responses to our RFI, the communications costs for use of the public network for daily GPRS/CDMA access for meters not covered by DLC would be \$40 per meter per year.

### **3.9.3. Public Wireless Network Connections to Concentrators, Meter Collectors and Transceivers – Scenarios 1b, 2b, 2c and 2d**

In all these scenarios, public network communication costs cover permanently connected public wireless network connections between the concentrators, meter collectors or transceivers and the relevant network management systems. Based on responses to our RFI, the data communication costs would be \$80 per annum for each concentrator, meter collector or transceiver.

#### *DLC Concentrators – Scenarios 1b and 2b*

The costs of data communications between 37,726+ DLC concentrators and the DLC NMS system amount to a total of \$3m+ per annum across Victoria.

#### *Mesh Radio Data Collectors – Scenario 2c*

The costs of data communications between the mesh radio data collectors and the mesh radio NMS system increase as the number of mesh radio data collectors' increases. For example, when there are 6,000 data collectors, the costs amount to a total of \$0.48m per annum across Victoria.

#### *PLC Transceivers – Scenario 2d*

The costs of data communications between 223+ PLC substation transceivers and the PLC NMS system amount to a total of \$18k+ per annum across Victoria.

#### *PLC Transceivers for Rural Areas for Scenarios 2b and 2c*

The costs of data communications between 109+ rural PLC substation transceivers and the PLC NMS system amount to a total of \$8.7k+ per annum across the relevant distribution businesses serving those rural customers where PLC is being used.

### 3.10. INCREMENTAL IT CAPITAL COSTS

#### 3.10.1. Network Management System (NMS)

All advanced communications rollout scenarios will involve additional costs for the provision of a Network Management System (NMS), to be based on open access and open technology for integration with MDA applications. NMS costs are the same for scenario 1a as for scenario 2a, because the scale is similar. NMS costs are likewise the same for scenario 1b as for scenario 2b in the urban areas (but the costs differ in respect to the use of GPRS/CDMA in rural areas in scenario 1b, as against PLC in scenario 2b). NMS costs do, however, differ by technology. This is because they are controlling different hardware doing different functions.

All prices quoted in this section of the report include the costs of:

- all hardware;
- all software;
- database of meters, meter readings (stored from meter collectors);
- systems integration with MDA applications (a replacement for the interface that would receive uploads for manually read data); and
- implementation costs including project management, change management, etc.

In each case, allowance has also been made in our model for system replacements in year 10.

##### *Wireless (GPRS or CDMA) Technology – Scenarios 1a and 2a*

A NMS is required to operate the network and to act as a message broker between the meters and IT systems. Several providers of these systems submitted responses to the RFI and provided capital costs in the range of \$1m to \$5m. A figure of \$1.9m has been used in the model, because this was from a vendor with considerable experience in NMS for GPRS in Victoria.

##### *DLC Technology – Scenarios 1b and 2b*

The NMS is a key part of the DLC system. As there are several companies providing DLC systems based on ANSI 709, there are several providers of NMS. A key function of an NMS is to keep track of all meters, so that with re-configurations of the LV networks the NMS knows which meters are attached to which data concentrators. The NMS also monitors the communications integrity through to data concentrators.

The pricing of NMS ranges from about \$2m to \$5m. For the purposes of this study, an NMS cost of \$4.3m per distribution business has been used as this represents the NMS costs for those providers with the greatest level of implementation experience of NMS.

The price of the NMS for the PLC system is \$0.7m including system integration costs. Our cost model provides for one NMS for each of United Energy, SP AusNet and Powercor, being those distribution businesses that serve rural areas.

#### *Mesh Radio – Scenario 2c*

The NMS capex costs (hardware, software and implementation) submitted by the major mesh radio providers range from \$1.5 m to \$2.3m per distribution business. The price of \$2.3m has been used in the model as this was from the vendor with most mesh radio experience. One NMS has been allowed per distribution business.

The price of the NMS for the PLC system is \$0.7m including system integration costs. Our cost model provides for one NMS for each of United Energy, SP AusNet and Powercor, being those distribution businesses that serve rural areas.

#### *PLC – Scenario 2d*

The NMS capex costs (hardware, software and implementation) submitted by a major PLC provider are shown in Table 16 below. This provider costs its NMS on a per end-point basis.

**Table 16: Network Management System Costs – PLC Technology**

<b>Distribution Business (MDA)</b>	<b>Capex Cost (\$m)</b>
<b>AGLE</b>	\$0.76
<b>CitiPower</b>	\$0.76
<b>United Energy</b>	\$1.62
<b>SP AusNet</b>	\$1.55
<b>Powercor</b>	\$1.71
<b>Total</b>	<b>\$6.40</b>

Costs of systems integration with MDA systems are estimated to be an additional \$0.5m per distribution business.

### **3.10.2. Connect/Disconnect System**

All advanced communications rollout scenarios involve additional costs for the provision of a connect/disconnect system. This system is required to control the connect/disconnect contactors in each of the meter to allow remote energisation and re-energisation of supply to customers. The capital cost for the system is \$2.1m per DB and is inclusive of:

- all hardware;
- all software;
- systems integration with MDA applications; and

- implementation costs including project management, change management, etc.

### 3.10.3. Other Incremental IT Capital Costs

Distributors and retailers are already investing in new IT systems in order to use interval data from the IMRO meters, so there are no other incremental IT capital costs in scenario 1.

In scenario 2, the need to handle larger volumes of data would be brought forward, due to accelerated rollout of interval meters. We expect that the software systems being implemented for IMRO will be designed to cope with these volumes of data, which would be required anyway at some stage under IMRO. There may be requirements for additional storage capability to be available earlier to hold the additional data – this may not represent a material additional cost.<sup>18</sup>

For daily reading, the IT costs for Meter Data Management (MDM) should be either the same or less than what would occur with IMRO. On the basis of the quantity of data, the cost should be the same as the amount of interval data is the same – but with daily reading it comes in smaller packets. Further, with manually read interval meters the metering data would come in batches at the end of each business day as PDEs are returned to depots and uploaded. With daily reading through remote communications, the volume of data can be spread over more hours of the day. According to a leading billing systems vendor, this would reduce the sizing of the hardware required, as there is less data per hour to process. Hence a conservative approach is the leave the IT systems costs for MDM and back end systems to be the same for daily reading using advanced communications as it is for IMRO.

## 3.11. INCREMENTAL IT OPERATING COSTS

Incremental IT operating costs relate to the new Network Management and Connect/Disconnect systems, referenced above. The associated costs will cover operating these systems, as well as additional costs of any ongoing incremental hardware maintenance and software licensing. The figures given here, which are sourced from vendors, are broadly in line with the commonly accepted view that annual operating costs are 20% of capex costs (covering software licenses and hardware maintenance), plus system operator labour costs.

### 3.11.1. Wireless (GPRS or CDMA) – Scenarios 1a and 2a

For scenarios 1a and 2a, the annual incremental operating cost is \$0.9m per distribution business (including 1 FTE for system operations), which is \$4.5m across all distribution businesses.

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<sup>18</sup> It has been estimated that additional storage may cost around \$500,000.

### 3.11.2. DLC – Scenarios 1b and 2b

For scenarios 1b and 2b, the annual incremental operating cost is \$7.3m for 5 DBs, comprising the following:

- Operating cost of DLC NMS system at \$0.91m per distribution business – including software licence cost, hardware maintenance contract, and 0.5 FTE for system operations.
- Operating cost of PLC NMS system at \$0.12m for each of 3 distribution businesses – including software licence cost, hardware maintenance contract and 0.2 FTE for system operations.
- Operating cost of Connect/Disconnect system at \$0.47m per distribution business – including software licence cost, hardware maintenance contract and 0.5 FTE for system operations.

### 3.11.3. Mesh Radio – Scenario 2c

For scenario 2c, the annual incremental operating cost is \$4.76m including the following:

- Operating cost of Mesh Radio NMS system at \$0.41m per distribution business – including software licence cost, hardware maintenance contract, and 0.5 FTE for system operations.
- Operating cost of PLC NMS system at \$0.12m for each of 3 distribution businesses – including software licence cost, hardware maintenance contract, and 0.2 FTE for system operations.
- Operating cost of Connect/Disconnect system at \$0.47m per distribution business – including software licence cost, hardware maintenance contract and 0.5 FTE for system operations.

### 3.11.4. PLC – Scenario 2d

For scenario 2d, the total annual incremental operating cost across all distribution businesses is \$3.9m – including software licence cost, hardware maintenance contract, and 1 FTE for system operations for each distribution business.

## 3.12. BENEFITS AND COSTS BEYOND YEAR 20

It has been suggested that because the existing electromechanical meters have an assumed life of 40 years, whereas the new electronic interval meters have an assumed average life of only 14.5 years, there may be some additional costs in outbound years that are incurred in replacing meters again, which are masked by ending the analysis before then. The issue arises specifically in scenario 2, where we accelerate the rollout of single phase non-off-peak meters relative to IMRO.

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One way to handle this would be to extend the full benefit costs analysis to 40 years, but we believe that would be unnecessarily complex, and given future uncertainties (particularly in technology) a benefit cost analysis beyond 20 years loses reliability.

We have instead considered that the issue arises, relative to IMRO, only in respect of those non-interval meters that under IMRO remain in place after 18 years (in 2025). Our model shows that approximately 0.5 million of those meters would be in place at that time in the IMRO scenario. Under IMRO those meters are already about 20 years old at 2025, and therefore will need to be replaced anyway during the next 20 years (2025 to 2045). Under scenario 2, their replacement will be advanced slightly, to the end of 2033 – 20 years after the end of the accelerated period of their installation, which in scenario 2 is in 2013. These would be the only incremental costs relative to IMRO in the period 2025 to 2045.

Against that, there are strong positive benefits from 2025 to 2045, from avoided meter reading costs, and other benefits that are included in this report. Given that those benefits would exceed costs of a full rollout in the years up to 2025 in any recommended rollout, it seems clear in this case that the benefits would continue to exceed costs in the next 20 years, where the incremental costs relative to IMRO would be much lower, yet the benefits would continue at the same rate as in the previous 20 years.

## 4. BENEFIT ASSUMPTIONS

There are a variety of potential benefits associated with communications functionality, not all of which are easily quantified.

This section documents the input data and assumptions that were used to estimate incremental benefits for each scenario. The largest category of benefits quantified in this study comes from avoiding the cost of manual meter reads for both regular and special reads. Other benefits include capacity savings from demand response due to more widespread use of time-varying pricing ... [to be completed]

### 4.1. AVOIDED COST OF REGULAR MANUAL METER READS

The largest single benefit is the avoided cost of manual meter reads. Residential meters are generally read quarterly in Victoria, and business meters are read monthly<sup>19</sup>. The cost of reading IMRO meters manually is higher than the cost of reading accumulation meters.

- In scenario 1, benefits accrue from the avoided cost of reading IMRO meters, as these will now be read using remote communications capabilities.
- In scenario 2, there are avoided costs from manual reading of all meters – accumulation meters and interval meters.

With communications functionality, meters can be read remotely, thus avoiding the cost of manual meter reads. Importantly, the avoided cost of manual meter reads is not proportional to the number of remotely read meters. Indeed, if the number of remotely read meters is relatively small and randomly distributed across all meter read routes, arguably, it may not be possible to reduce the number of meter readers substantially or at all.

The EDPR Final Decision (Table 13.31, p. 545) contains information on the average cost of manual meter reads for both accumulation and interval meters. There are significant differences for some distributors between the costs submitted by the distributors for the EDPR and those that are contained in the Final Decision. For example, AGLE submitted cost estimates of \$0.81-\$0.95 per read for accumulation meters and \$3.12-\$3.64 for interval meters, whereas the Final Decision allows \$0.75 and \$1.50, respectively. On the other hand, the costs submitted by CitiPower are the same as the Final Decision, and the costs submitted by United Energy are lower than the Final Decision costs for interval reads.

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<sup>19</sup> We understand there may be some exceptions to this: some very large usage residential customers may have their meters read monthly and some very small usage commercial customers may have their meters read quarterly. These exceptions do not materially change the analysis.

For the more rural areas covered by Powercor and SP AusNet, the Final Decision allows \$1.50 for accumulation meters and \$2.50 for interval meters. These allowed values are the same as the Powercor submission estimates, but significantly less than the SP AusNet submission for interval meters (\$3.09-\$3.88).

The allowances for meter reading are shown in Table 17.

**Table 17: Manual Meter Reading Costs (\$ per Meter Read)**

Distributor	Accumulation Meter	Interval Meter
<b>AGLE</b>	\$0.75	\$1.50
<b>CitiPower</b>		
<b>United</b>		
<b>Powercor</b>	\$1.50	\$2.50
<b>SP AusNet</b>		

When estimating the avoided costs associated with adding communications to meters for scenarios 1a and 1b, we assumed that there would be no decrease in the number of meter readers relative to the number needed if all meters were manually read accumulation meters. We believe there may be some savings in manual reading costs, but the amount of walk or drive time needed to cover the distribution service areas may be difficult to quantify. Determining how much it might fall is difficult without assuming a deployment pattern and re-optimising read routes (which is beyond the scope of this study). Therefore, we assumed no change for scenarios 1a and 1b.

There are still substantial savings associated with remote meter reading for these scenarios, because we are avoiding the more time consuming and expensive IMRO reads, and we have assumed that the number of meter readers needed is the same as if all meters were accumulation meters. In scenario 2, on the other hand, we assume that all costs of manual meter reading are eliminated.

#### 4.2. AVOIDED COSTS OF SPECIAL METER READS

Special reads and de-energisations / re-energisations are often deployed upon change in occupancy and are costly to undertake. This is a significant cost for many retailers, which would be avoided with advanced communications rollout.

Currently in the model, we calculate this at between 25% and 34% of customers (depending on the distribution business area) each year at a cost equal to what is in the Excluded Service tariff for each distributor, as shown in Table 18

**Table 18: Special Meter Reading excluded service charges**

Distributor	Special Read Cost
AGLE	\$20.91
Citipower	\$23.82
Powercor	\$19.97
SPAusNet	\$21.95
United Energy	\$29.91

### 4.3. REDUCED PORTABLE DATA ENTRY COSTS

Portable Data Entry (PDE) units are required in order to download interval metering data from IMRO meters to the distributors' IT systems. With communications, many of these devices would not need to be purchased or maintained, as these are only used to retrieve interval data.<sup>20</sup>

The EDPR Final Decision (Table 13.21, p. 536) contains the following allowances for the purchase of PDEs for each distributor for the provision of metering data services: \$200,000 for AGLE; \$400,000 for CitiPower; \$900,000 for Powercor; \$1 million for SP AusNet; and \$1 million for United. These values exclude maintenance and any additional purchases that might be needed later.

The total avoided cost of PDEs in our model over the 20 years of our analysis is based on these numbers, and a PDE average life of 3 years.

### 4.4. AVOIDED BATTERY REPLACEMENT

Battery manufacturers only guarantee the life of batteries within electricity meters for 10 years. Therefore, where meters with batteries are used, as in the case of IMRO, there is need for a battery replacement program to commence ten years after these meters start to be rolled out. In this study, all scenarios specify meters without batteries, and therefore there is a saving from this replacement program being avoided.

The saving that results is the cost of the replacement batteries and the labour to replace the batteries. The battery cost assumed is \$3, and the labour to replace is calculated at an average of 20 minutes per meter, assuming that the batteries are easily accessible under the terminal cover of a meter. The time is based on the process of:

- travel time from previous property;
- locating the meter;

<sup>20</sup> A smaller number would be needed for use where data needed to be downloaded from site due to long-lasting communications failures or other special circumstances.

- removal of the meter terminal cover;
- removal of old battery;
- insertion of replacement battery;
- affixing a label to indicate that battery replacement has been done;
- replacement of terminal cover; and
- applying a new meter seal.

The labour rate assumed is \$80 per hour, and the number of meters requiring battery replacement is the total number of meters installed under IMRO each year – the batteries in these meters will need to be progressively replaced starting from 10 years after IMRO commences.

#### **4.5. AVOIDED RETAILER COSTS**

With the implementation of advanced communications enabling remote meter reading there is a range of areas where retail costs will be reduced. The largest of these appears to be call centre costs. Information from retailers would indicate that there are savings in relation to calls regarding, estimated bills, meter reader issues (including access and presence of readers on customers' properties), delayed bills and other categories. In some cases Retailers showed savings as a percentage of calls avoided, in other cases they were just total dollar estimates. It is our opinion that in some cases the avoided costs are underestimated.

#### **4.6. DEMAND RESPONSE BENEFITS**

Reducing peak demand, and thereby reducing the need for new generation, transmission and distribution capacity, was one of the primary motivations for the IMRO policy. IMRO meters support a wide variety of pricing options designed to reduce peak demand.

Demand Response (DR) benefits stem from the ability of interval metering to support time-varying pricing, which, in turn, leads to reductions in peak-period energy use. Reductions in peak-period energy use, in turn, reduce the need to expand generation, transmission and distribution capacity and can reduce the average delivered cost of electricity even in the short run, by shifting energy use from the peak to the off-peak period when wholesale prices are lower and/or when network charges are lower.

The extent to which adding communications capabilities to IMRO in either scenario 1 or scenario 2 will give enhanced demand response (DR) has been a matter for some debate during the course of conducting this study.

#### 4.6.1. Scenario 1

In scenario 1, adding communications to IMRO meters does not necessarily produce incremental DR benefits, since time-varying pricing can be supported with manually read IMRO meters, albeit with significantly delayed billing, which, some have argued, may diminish demand response. Thus, the pricing options available with and without communications functionality are largely the same. Adding communications may give enhanced demand response for IMRO customers through the use of enabling technology – smart thermostats, in-home notification devices, direct load control devices, etc. However, using the meter communication channel for these devices may not be the least cost option, and there are certainly methods of providing this capability in the absence of advanced meter communications.

In order to be conservative, we have therefore not included any estimates of incremental benefits for enhanced load management in scenarios 1a and 1b. In fact, we have allowed for reduced benefits from DR in scenario 1 as compared to IMRO – due to deferment of the IMRO program in scenario 1. Given that as far as we are aware the retailers are not currently planning any significant tariff reforms to take advantage of IMRO to encourage DR in the first few years after IMRO deployment commences, taking this deferment of IMRO in scenario 1 as an indicator of reduced DR benefits is very conservative, as in those first few years there are unlikely to be any DR benefits that are lost through deferment.

#### 4.6.2. Scenario 2

Under scenario 2, many more interval meters are installed over the forecast horizon and the incremental benefit associated with these meters is estimated in this study.

Estimating demand response benefits requires the following information:

- Estimates of energy use during the peak period in the absence of time-varying prices;
- A forecast of prices by rate period that might be offered to customers;
- An estimate of the behavioural response of customers who will face those prices;
- An estimate of the number of customers facing the prices; and
- Estimates of the avoided cost of generation, transmission and distribution capacity.

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Estimates of energy use during the peak period were taken from the IMRO Final Decision,<sup>21</sup> Table 8. The peak-period energy use per hour underlying the DR benefits equals 0.35 kWh/hr for the 20 working days during February.

We also used the same prices underlying the analysis from the IMRO Final Decision, as shown in Table 9 of that paper. The peak-period price is \$0.4470, and the base price is \$0.1418.

Behavioural response is based on demand models estimated from the California State-wide Pricing Experiment (SPP).<sup>22</sup> Estimates are based on a system of demand equations. One equation predicts the ratio of energy use in the peak and off peak periods as a function of the ratio of prices in the two periods and other factors and the other predicts average daily energy use as a function of average prices and other factors. The coefficient on the ratio equation, known as the elasticity of substitution, equals  $-0.076$ , and the daily price elasticity equals  $-0.041$ . The average reduction in peak-period energy use based on these values and the prices summarised above equals approximately 10 percent.

We have assumed that 100 percent of the incremental customers receiving meters in scenario 2 face time-varying prices. The DR benefits resulting from this assumption and the other assumptions summarised here equal approximately \$29 million in present value terms. These benefits are directly proportional to the number of customers assumed to face time-varying prices. Thus, if only half of all customers face time-varying prices, the total benefits would equal roughly \$14.5 million. On the other hand, if time-varying pricing were targeted at specific customer groups, such as air conditioning owners or other large users, the same benefits could be achieved with fewer customers, as results from the California pricing experiment as well as other experiments show that air conditioning owners and other large users have higher demand response than do non-air conditioning owners. Indeed, analysis of the California SPP shows that roughly 80 percent of total DR benefits can be obtained from just 30 percent of customers that are larger users, more responsive and have high saturations of air conditioners. Thus, a targeted pricing strategy could be quite effective in producing significant demand response benefits.

The final assumptions underlying the estimates of demand response are the avoided cost of capacity. We used the same values that were used in the IMRO Final Decision, namely, \$80/kW-yr for generation, \$20/kW-yr for transmission and \$30/kW-yr for distribution.

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<sup>21</sup> Essential Services Commission. *Implementation of Interval Meter Rollout Decision – Variations to the Electricity Customer Metering Code and Metrology Procedure, Final Decision*. November 2004. p. 38.

<sup>22</sup> Charles River Associates. *Impact Evaluation of the California State-wide Pricing Pilot*. March 16, 2005.

#### 4.7. COMPETITION BENEFITS

It has been suggested that the rollout of IMRO will enhance competition in the market, particularly for customers with substantial off-peak usage. Deferring IMRO in scenarios 1 and 2 may forego some of these benefits in the short term, while accelerating rollout in scenario 2 may enhance the benefits in the longer term.

Our discussions with retailers have indicated to us that they are not yet ready to launch products that take account of the interval data available from IMRO. Deferring IMRO would thus not defer any competitive benefits in reality in the short-term, but accelerating IMRO in scenario 2 could enhance competitive benefits in the longer term.

We have not quantified any of these influences on competition in this analysis.

## 5. RESULTS

### 5.1. OVERVIEW OF RESULTS

Table 16 contains estimates of costs, benefits and net benefits for each of the six deployment/technology scenarios that were examined. In all cases, these are relative to the costs and benefits of the IMRO deployment plan. All values in the table represent the net present value in 2005 dollars over the 18 year life of the investment. Three of the six scenarios have positive net benefits relative to IMRO: the accelerated rollout DLC private network at \$79 million, the accelerated mesh radio private network at \$26m and the accelerated rollout PLC private network at \$61 million. The IMRO schedule DLC private network solution has marginally negative net benefits.

The two scenarios using the public wireless communication systems (GPRS/CDMA) are significantly more costly than the private network options. For the IMRO deployment schedule, incremental costs exceed incremental benefits by \$269 million. For full deployment, incremental costs exceed incremental benefits by \$523 million.

**Table 19: Cost Benefit Analysis Results**

Categories of Incremental Costs and Benefits	Net Present Values (\$m)					
	Scenario					
	1a	1b	2a	2b	2c	2d
<b>Capital Costs</b>						
<b>Meters and Meter Communications</b>	276	44	477	111	216	220
<b>Communications Network Infrastructure</b>	-	29	-	37	39	18
<b>Network Management System</b>	26	54	26	41	29	23
<b>Project Management</b>	6	5	9	6	6	6
<b>Operational Costs</b>						
<b>Installation of Meters and Meter Communications</b>	111	-23	300	71	71	71
<b>Network Infrastructure Maintenance</b>	-	2	-	2	6	0
<b>Wireless Network Usage Charges</b>	55	64	104	29	4	0
<b>Network Management System</b>	38	80	38	57	37	32
<b>Total Costs</b>	<b>512</b>	<b>254</b>	<b>954</b>	<b>353</b>	<b>406</b>	<b>371</b>
<b>Benefits</b>						
<b>Avoided Meter Reading Costs</b>	136	136	191	191	191	191
<b>Avoided Special Reads</b>	81	81	154	154	154	154

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Categories of Incremental Costs and Benefits	Net Present Values (\$m)					
	Scenario					
	1a	1b	2a	2b	2c	2d
<b>Avoided Meter Battery Costs</b>	28	28	28	28	28	28
<b>Avoided PDE Costs</b>	3	3	9	9	9	9
<b>Avoided Retailer Costs</b>	12	12	23	23	23	23
<b>Incremental DR</b>	-17	-17	27	27	27	27
<b>Total Benefits</b>	<b>243</b>	<b>243</b>	<b>432</b>	<b>432</b>	<b>432</b>	<b>432</b>
<b>Net Benefits</b>	<b>-269</b>	<b>-12</b>	<b>-523</b>	<b>79</b>	<b>26</b>	<b>61</b>

The benefits are constant across the various technologies, varying only between the IMRO schedule scenario and the full deployment scenario. With a total NPV of \$432 million, benefits under the full deployment scenarios are around 60 percent greater than they are under the IMRO schedule scenarios, where benefits equal \$243 million. The most significant benefit derives from the avoided cost of manually read, normal cycle reads. This avoided cost accounts for about 45% of the total benefits for the full deployment scenarios, and about 55% of total benefits for the IMRO schedule scenario.

The second largest share of benefits, at 35 percent of total benefits for the full deployment scenarios, is the avoided cost of special meter reads and de-energisations/re-energisations. The \$28 million savings associated with avoided battery replacement accounts for about 6.5 percent of the total benefits for the full deployment scenarios. The demand response benefits, at \$29 million for the full deployment scenarios, accounts for 7 percent of total benefits. Demand response benefits are negative for the IMRO schedule scenarios because of the assumed three-year delay in rollout of any interval meters under these scenarios, compared with the current IMRO schedule.

Avoided retailer costs account for 5 percent of benefits. An additional \$9 million in benefits is achieved in the full deployment scenarios (\$3 million in the IMRO scenarios) by eliminating the need for Portable Data Entry devices used by meter readers.

The list of benefits included in our analysis is quite narrow, essentially including only:

- the avoided cost of regular and off-cycle reads and associated PDE costs;
- avoided retail costs mainly related to call centre activity;
- the avoided cost of battery replacement; and
- the benefits of price-induced demand response associated with the incremental customers on interval meters for the full deployment scenario relative to the IMRO schedule.

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There are many other quantifiable benefits that will almost certainly accrue from full scale deployment of advanced metering that we were not able to quantify due to lack of information from stakeholders and the relatively high-level nature of the project (compared with the “drill-down” that occurs when company-specific business cases are completed). These other quantifiable benefits include better outage detection, elimination of estimated bills, and elimination of profiling for settlement. Typical business case analysis projects in North America have found that quantifiable benefits such as these can amount to 100 to 300 percent of the savings associated with elimination of normal meter reads. In addition, there are many non-quantifiable benefits that may also accrue, such as faster and more accurate settlement, improved customer satisfaction, and product/service innovation. We are confident that a more thorough investigation of benefits would substantially improve the already attractive net benefit estimates reported here.

The present value of capital and operating costs over the life of the investment for the full deployment scenarios vary dramatically between the public and private network systems, from a low of \$353 million for the DLC scenario to a high of \$954 million for the wireless public network scenario. The very high costs for the public network options are due in part to the assumed need to replace the communication modules after ten years, due to the likely obsolescence of the GPRS/CDMA technology, and in part to the network usage charges associated with reading more than 2 million meters.

## 5.2. DISCUSSION OF COST RESULTS

A discussion of some of the interesting aspects of the incremental costs follows.

### 5.2.1. Capital Costs

#### *Meters and Meter Communications*

The incremental cost for meter and meter communications vary across scenarios for three primary reasons:

1. Differences in average cost of meters due to differences in technology and the impact of scale effects for single phase meters in the full deployment scenarios relative to the IMRO schedule scenarios;
2. The difference in the number of meters deployed in the full deployment scenarios relative to the IMRO schedule scenarios; and
3. The need to replace the communication modules after 10 years for the public network scenarios based on the assumed obsolescence of the GPRS/CDMA technology.

The net present value of the incremental meter and communication modules ranges from a low of only \$44 million for the private network option under the IMRO schedule scenario (1b) to a high of \$477 million for the public network, full deployment scenario. For the three private network full deployment scenarios, the DLC option (2b) has the lowest incremental cost, at \$111 million, while the mesh radio technology (2c) has the highest, at \$251 million.

The differences in costs across the DLC, mesh radio and PLC technology options are driven purely by the differences in meter prices reported in Table 10 to Table 14 in section 3.4. The lowest incremental costs are for the DLC technology. As seen in Table 10, based on a combination of scale effects and manufacturing experience gained through the large scale implementation of this technology in Italy, there is reason to believe that the incremental cost of these meters relative to IMRO costs is low, in spite of the inclusion of communication modules and connect/disconnect contactors in the meters. It should also be noted that given the rapidly declining cost of advanced meters in markets around the world, the assumed delay in IMRO implementation until 2008 or 2009 could cause these costs to drop even further relative to those assumed in this study, so the net benefits could be even greater.

#### *Communications Network Infrastructure*

We noted in section 3 that the capital cost of the communications infrastructure is associated with the cost of concentrators/collectors/transceivers (CCTs) for the private network systems that are used to retrieve data from meters and send it upstream to a centralized data repository. The number, type and cost of CCTs vary significantly across technology options, with DLC needing the greatest number of CCTs and PLC needing the fewest. The public network scenarios do not use concentrators, as the data is sent directly from meters to the central data repository. As seen in section 3.7, the number of collectors required for the mesh radio technology is one-sixth as many as for the DLC option, but the cost for each collector is roughly six times greater than for a DLC concentrator, so the total cost is almost identical for these two options. Even though the cost for each CCT for the PLC technology is between \$60,000 and \$90,000, very few transceivers are needed so that the total cost for the PLC technology is roughly half that of the DLC and mesh radio technologies.

#### *Network Management System*

As discussed in section 3.10.1 above, the cost of the Network Management System is technology dependent.

Scenarios 1a and 2a have the same technology and therefore the same cost for a Network Management System. However, the Network Management System costs of scenarios 1b and 2b differ, due to the differences in the solution for those rural customers for whom DLC is not suitable (CDMA in scenario 1b as against PLC in scenario 2b).

### *Connect / Disconnect System*

As discussed in section 3.10.2 above, there is a need for a Connect / Disconnect IT system to enable the functionality in the meters for remote connection and disconnection.

### *Project Management*

Incremental project Management costs are higher in scenario 2 than in scenario 1, due to the larger project scale.

Scenarios 1a and 2a (and to a lesser extent 1b) have some allowance for the 10 year GPRS/CDMA replacement. This explains why the project management cost of scenario 1a is higher than that of scenario 1b, and the project management cost of scenario 2a exceeds that of scenarios 2b, 2c or 2d.

## **5.2.2. Operational Costs**

### *Installation of Meters and Meter Communication Replacements*

The incremental installation costs also vary significantly across scenarios, ranging from a low of -\$23 million for the private network, IMRO schedule scenario (1b) to a high of \$300 million for the public network, full deployment scenario. The reasons for the variations are as follows:

- Scenario 1b has a negative net present value incremental installation cost due to deferment of IMRO.
- The installation costs of scenario 1a are higher, due to the costs associated with the 10 year GPRS and CDMA replacement program.
- Scenario 2b, 2c and 2d installation costs reflect the much larger number of meters being installed in scenario 2 as against IMRO or scenario 1.
- Scenario 2a installation costs are higher for the same reason that scenario 1a installation costs were higher than scenario 1a installation costs: the extra cost reflects the 10 year GPRS and CDMA replacement program.

### *Network Infrastructure Maintenance*

We note that the network infrastructure maintenance cost of scenario 2d is not actually zero – it shows as zero simply because it is less than \$0.5m.

### *Wireless Network Usage Charges*

Similarly the wireless network usage charges for scenario 2d is not zero – it again shows as zero simply because it is less than \$0.5m.

The wireless network usage charges are large for scenarios 1a and 2a due to the use of GPRS/CDMA at all meter end-points in these scenarios.

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The wireless network usage charges are also large for scenario 1b – due to the large number of distribution transformers, and the use of GPRS/CDMA in rural areas in this scenario. The charges are also significant for scenario 2b due to the large number of distribution transformers.

### 5.3. SENSITIVITY ANALYSIS

We have undertaken sensitivity analysis on the following aspects of our cost and benefits assumptions:

#### 5.3.1. The Discount Rate

Because benefits generally follow costs chronologically, increasing the discount rate gives lower net benefits in real terms. Increasing the discount rate to 8% gives the following results:

**Table 20: Cost Benefit Analysis Results with Discount Rate 8%**

Scenario		Net Present Value (NPV)		
Rollout	Communications	Benefits (\$m)	Costs (\$m)	Net Benefits (\$m)
1: IMRO	(a) Wireless	201	417	-216
	(b) DLC		204	-4
2: Accelerated Rollout	(a) Wireless	365	828	-463
	(b) DLC		317	48
	(c) Mesh radio		366	-1
	(d) PLC		335	30

#### 5.3.2. Savings on Accelerated Rollout

The reduction in costs associated with the accelerated rollout of meters in scenario 2 is very modest. We believe that the average reduction in costs that could be achieved through efficiencies in rapid meter deployment under scenario 2 could be between \$10 and \$30 per meter, although it is difficult to know for sure without issuing a formal RFP. If such savings could be realised, the reduction in total costs, and the resulting increase in net benefits, could be substantial, however. A reduction in installation costs of only \$10 per meter could increase net benefits for Scenario 2b, for example, \$79 million to \$98 million.

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**Table 21: Cost Benefit Analysis Results with \$10 Reduction in Accelerated Installation Costs**

Scenario		Net Present Value (NPV)		
Rollout	Communications	Benefits (\$m)	Costs (\$m)	Net Benefits (\$m)
1: IMRO	(a) Wireless	243	512	-269
	(b) DLC		254	-12
2: Accelerated Rollout	(a) Wireless	432	920	-489
	(b) DLC		334	98
	(c) Mesh radio		387	45
	(d) PLC		351	80

### 5.3.3. Contingencies on Costs and Benefits

We were asked to calculate the benefit cost analysis with 10% contingency on costs. The results are given in Table 22 below.

**Table 22: Cost Benefit Analysis Results with 10% contingency on capital and operating costs**

Scenario		Net Present Value (NPV)		
Rollout	Communications	Benefits (\$m)	Costs (\$m)	Net Benefits (\$m)
1: IMRO	(a) Wireless	243	663	-320
	(b) DLC		280	-37
2: Accelerated Rollout	(a) Wireless	432	1,050	-618
	(b) DLC		388	43
	(c) Mesh radio		447	-15
	(d) PLC		408	24

## 6. RECOMMENDATIONS AND NEXT STEPS

### 6.1. OVERVIEW

The analysis presented in this report indicates that the net benefits from full deployment of interval metering with two-way communications in Victoria are significant. Even though we did not quantify many of the potential benefits that are possible with advanced metering, the present value of net benefits relative to IMRO is estimated to equal between \$79 million for the DLC scenario. In many installations of advanced metering in North America, it has been found that realised benefits exceeded the benefits estimated during the business case leading up to a decision to deploy, and we have no reason to believe that a similar result would not be achieved in Victoria. As such, **we recommend that the Victorian Government and electricity supply industry should progress activities to result in accelerated rollout of interval metering with advanced communications across Victoria, in accord with scenario 2 as presented in this study – as an enhancement of the existing IMRO decision.**

This study provides a positive benefit-cost analysis based on basic functionality of two-way meter communications with remote meter reading capabilities, and remote connect and disconnect. That does not preclude the actual roll-out providing greater functionality. If rollout is to proceed, further work is needed to get input from Government, retailers, distributors and MDAs, on what specification they would expect for advanced communications rollout. Now that a positive benefit-cost analysis has been established for scenario 2, there is a need to consider what further enhanced rollout functionality can and should also be supported.

### 6.2. TIMEFRAME

Our analysis was based on a schedule in which rapid deployment of advanced metering would commence in January 2009. While there are many additional steps that need to occur between a decision to move forward and putting the first meter in place, the primary reason for delaying implementation until 2009 in our analysis was a belief by some that ramping up more quickly could encounter a skilled labour shortage that would either prolong or delay the deployment process. We believe that this potential barrier should be explored more fully as one of the immediate next steps, as it is likely that other issues could be addressed within the next 12 to 18 months, thus allowing for deployment to start sooner, and for Victoria to begin receiving the benefits of advanced metering more quickly.

In order to allow for these important further steps to be undertaken, and to avoid the additional costs that would be incurred if manually read interval meters were to begin deployment in 2006, only to be replaced soon thereafter with communicating meters, we recommend that the planned start of IMRO meter deployment be deferred. At a minimum, the deferral should initially be for one year, during which a final decision can be made regarding the new recommended policy. As indicated above, we believe it is possible to settle all issues in time to allow full-scale deployment of advanced meters to commence no later than 1 January 2008, and perhaps sooner (assuming no labour shortage).

### **6.3. COMPETITION IN METER PROVISION AND METER DATA SERVICES**

As noted in section 1.1, the National Electricity Rules enable retailers to be the responsible person for interval metering with communications. There is, however, a derogation from the rules to allow the distribution companies a monopoly on meter provision and meter data services specifically for manually read interval meters in order to achieve a rollout of these meters. The recommendation in this study that there be a rollout of advanced interval meters raises the issue of whether there is a need to extend the monopoly on metering service provision and meter data services granted to the distribution businesses in this derogation to interval meters with communications as well, in order to achieve a rollout. Such an approach would in some respects make the rollout simpler however it would reduce competition for the vast majority of metering.

A second option is for the retailers to undertake the rollout of interval meters with communications. This option has a level of complexity about it. The distributors currently have funding for an interval meter rollout, and this study deals with the incremental costs of adding communications. Given that with the private network scenarios (with positive net benefits) the customer end communications components are integral in meters, a rollout of communications components separate from meters is rather difficult. Hence for the retailers to undertake a rollout they would have to take on both interval metering and communications, and also have a cost recovery mechanism for so doing. Distribution businesses would then not be allowed the funding given for IMRO. There is also the complexity of private network infrastructure. Would each retailer rollout their own set of data concentrators for each geographic area? In the DLC situation, would the distribution businesses give the retailers access to the LV network?

A third option is what appears to be happening in Ontario, where they have created a Smart Metering Entity that has centralised procurement and owns the upstream network management and MDA activities, but “the last mile” from concentrators to meters is owned by distributors.

A fourth option is to allow the retailers to be the Responsible Person for both meter service provision and meter data provision, but have the distribution businesses mandated to rollout advanced interval meters to all Victorian electricity customers. The retailers could then choose whether they wished to use the distribution businesses' metering and communications or appoint other providers. Where a retailer chooses not to use the distribution business infrastructure, there would need to be a guarantee that the distributor is still recompensed for everything except actual direct avoided costs of someone choosing to use another network.

**It is recommended that the fourth option be implemented for advanced interval metering with communications.** With this option there would continue to be a level of competition in the metering and there would also be no change required to the national electricity rules. **It is also recommended that the distribution businesses be required to provide guaranteed service levels for all advanced interval metering services provided.**

#### 6.4. HARMONISED FUNCTIONALITY REQUIREMENTS

There is a need to develop a common functional requirement that will be mandated across the various AMI systems that will operate across the state. For example:

- For re-connection, whether all systems should have an option to “arm” the meter to enable the customer to press a button to cause reconnection, rather than just have the supply reconnected remotely.
- How optional in-home displays may be connected to the meter. If each distribution business' systems required different in-home displays with different capabilities and functions it may make it more difficult for retailers to have the same offering to all customers.
- What types of load management should be enabled? At a simple level what functionality should there be for hot water management. Options for remotely setting on and off times? Group commands for load shedding?
- What Quality of Supply (QoS) measures should there be? It would be useful if all systems measured the same QoS attributes the same way.
- What standard message types are required between retailers and DBs to initiate certain reading or connection / disconnection activities? Should this be an extension of what is provided in the B2B hub?
- What allowance should there be for remote reading of gas & water meters through these systems. Should there be an interface standard? Involvement of gas and water utilities will be necessary here.
- Would it be beneficial to have load shedding initiated at the meter level or data concentrator level?

There may be a need for a new metrology procedure for AMI meters.

**We recommend that the Victorian Government facilitate the development, in conjunction with the industry and the ESC, of a common functional requirement that will be mandated across the various AMI systems that will operate across the state.**

## 6.5. TRIALS

Another important activity is the conducting of technology trials and pricing experiments. Technology trials are important in demonstrating that certain technologies are adequate for meeting the requirements of advanced metering in the urban and rural areas. Further trials allow better understanding of the performance of systems and the operational issues associated with installations and operations.

It is also important that there be careful planning of trials and joint co-ordination of arrangements to ensure that there is little duplication of effort and to maximise sharing of results. There will need to be consideration as to the number of trial systems, what technologies are trialled, the scale of those trials, the funding of trials etc.

Pricing experiments could be useful in estimating the potential magnitude of demand-response savings from alternative pricing, both with and without enabling technology to help automate changes in energy use. They can also demonstrate customer acceptance of new pricing and demand-response options.

It is noted that trials are not needed in order to decide to move forward, as the estimates presented here are generally based on quite conservative assumptions about incremental costs and benefits. For example, the net benefits would still be positive if there were no demand response benefits at all, so there is no reason to wait to develop better estimates of demand response before deciding to move forward. On the other hand, demonstrating the potential magnitude of demand response and seeing how customers accept new pricing schemes could be very valuable to retailers and policymakers and be very helpful in achieving the full potential of advance metering down the line.

**We recommend that the Victorian Government facilitate a co-ordinated approach to AMI trials**

## 6.6. IMPLEMENTATION PLANNING

The final co-ordinated activity required is implementation planning. This is where the final business case for implementation is developed, presented and approved. All the details of common functionality to meet distribution and retail business interactions are defined carefully and full functional and operational specifications are developed.

In North America, implementation planning typically involves the following steps:

1. A very detailed analysis of the operational savings that are achievable from advanced metering implementation, including all of the benefit categories that were not explored in this study for reasons previously discussed. These benefits will vary with technology choice so they must be examined under multiple assumptions about system functionality.
2. Based to a large extent on the benefit analysis from alternative options done in step 1, development of a detailed functional specification for all aspects of the advance system, from meter functionality through to billing functionality, systems integration, etc.
3. Development of multiple RFPs detailing the specifications developed in step 2. To be effective, the RFPs for meters, installation, and communication systems must be based on a detailed delineation of meter and customer density, implementation schedule and other factors that affect costs. The RFPs are then sent to relevant vendors and suppliers as a means of obtaining firm cost information.
4. A detailed evaluation of the information obtained through the RFP process and an update of the business case based on this superior cost data.
5. Contract negotiation, which itself can be a relatively prolonged process but, when done effectively, can lead to additional improvement in cost data and, quite often, significant reductions in costs relative to the initial bids received.

This process typically takes between six and twelve months. In work recently completed for Pacific Gas and Electric Company, one of the largest US utilities with roughly 5 million electricity meters and 4 million gas meters, the change in the costs and benefits between the preliminary analysis and their most recent analysis (as filed in regulatory proceedings in California) were dramatic.

**We recommend that DOI in conjunction with the ESC provide detailed guidelines regarding the content and approach to the business cases that each distributor would develop, and establish a schedule for development and review of the business cases prior to approving implementation.**

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## APPENDIX A: OUR TERMS OF REFERENCE FOR THIS STUDY

# ENHANCED INTERVAL METER COMMUNICATIONS FUNCTIONALITY – STUDY BRIEF

## Final Draft – for Consultants

### 1. RECOMMENDATIONS

That the businesses listed below (see section 5):

1. support the conduct of a study, to be co-ordinated by DOI, into the optimal communication functionality requirements for a broad-based interval meter roll-out (IMRO) program in Victoria;
2. support the appointment of a consultant by DOI, to be jointly funded by DOI, electricity retailers and electricity distributors; and
3. support the Terms of Reference for the study below.

### 2. TERMS OF REFERENCE

The study will

- identify and assess the costs and benefits to the market of potential enhancements to communications functionality within a broad-based Victorian interval meter program.
- where there are assessed net benefits, identify the optimal nature, scale and timing of the deployment of that additional communications functionality; and examine the merit of incorporating that additional functionality in the current ESC IMRO program.
- identify strategies to most efficiently introduce that enhanced functionality over time to the defined market (including geographic) segments, having regard to the preference for market-driven deployment, but also considering any possible role of regulation.
- recommend a strategy for integrating appropriate enhanced functionality in the current ESC IMRO program, if this is determined to be an optimal approach.

### 3. BACKGROUND

On 9 July 2004 the Essential Services Commission (ESC) mandated the rollout of interval meters for electricity customers in Victoria. The rollout, based on a timetable related to customer size and meter type, will commence in 2006.

The ESC concluded that regulatory intervention is required to ensure that interval meters are rolled out in a timely manner and the associated benefits are captured. Interval meters have the potential to make consumers more aware of their level and pattern of electricity usage, leading to the potential for more efficient use of our energy supplies – in particular, avoided expenditure on new electricity infrastructure.

In its decision, the ESC requires that a basic level of communication functionality can be readily applied at a future time to meters installed under the IMRO program. The intention was to enable a form of remote reading capability where requested by a relevant party. Whilst this capability may be appropriate in a number of situations, it is not likely to facilitate the future application of enhanced functionality, such as two way data flows and automated usage control options.

Further, the ESC did not directly assess the other potential benefits to industry and consumers (such as those relating to network operations, retail service and energy efficiency). It is now argued that community expectations in a number of areas have since arisen that merit a re-examination of the relevant costs and benefits – these areas include energy conservation and greenhouse mitigation, and improvements in the reliability of supply networks and customer service standards. These expectations become more realisable when recent enhancements to the commercialisation of new technologies are also taken into account.

On 4 April 2005 Government convened a meeting of retailers, distributors and the ESC to discuss the potential case for enhanced communications functionality under a broad-based IMRO program. It was generally agreed that whilst there is a range of potential benefits, it has not been demonstrated to date that such benefits would outweigh the costs, and hence a change to the current ESC IMRO program is not justified at this stage.

However, at the meeting on 4 April there was general agreement that a study be coordinated by DOI to investigate whether there is merit in reinforcing and enhancing the potential long run benefits to consumers of the current IMRO program. The study would be designed to examine the case for enhanced functionality and whether, how and when it might be incorporated in the current IMRO program.

#### **4. PARTICULAR FACTORS TO BE CONSIDERED BY THE STUDY**

The key incremental benefit areas to be examined include the potential for:

- enhanced demand response opportunities, particularly resulting in deferred network and generation investment, compared to the gains anticipated to arise from the current IMRO program;
- more efficient wholesale purchasing by retailers with access to more timely and accurate consumption information;
- more accurate and timely detection of outages and voltage fluctuations, as well as other network capacity and performance management aspects;

- cost reductions arising from remote meter reading, taking into account the ancillary benefits of manual reading, such as meter inspection;
- improved customer service from remote connection and disconnection, taking into account the possible implications for electrical safety and consumer protection;
- the better management of theft and unknown customers; and
- economies of scope, for example with the reading of gas and water meters.

The Study should give regard to the potential costs arising from additional investment in meters, communications systems, and application software, and any stranding of assets.

A key focus of the Study should be the extent to which minimum desirable functionality should be incorporated in the basic meter, compared to what functionality should be enabled as a future “add-on”. The minimum communications functionality will depend on the requirements of individual customer situations and , in order not to lock-in certain technologies, should focus on potential outcomes of the relevant communications functionality. Broad examples of such outcomes may include:

- the collection of usage data at prescribed intervals that supports customer understanding of usage patterns;
- the capability for time interval based pricing within specified notification periods;
- access by customers to personal usage data that enables the customer to relate usage patterns to energy prices;
- the capability to interface with remote meter reading systems;
- the capability to interface with load control communication technology.

To ensure that the identified outcomes are achievable, it is expected that the Study will make recommendations that minimise barriers to access and use of relevant data. In this regard, consideration should also be given to non meter-based communication functionality.

Any enhancement to communications functionality for which merit is demonstrated by the Study is likely to affect implementation of the current ESC IMRO program. The Study should therefore recognise the clear practicalities of varying the scope of the roll-out compared to the current IMRO decision. Close consultation with the ESC and other stakeholders will be required on this issue and, where possible, early advice would be sought on mitigating any adverse impacts on the parties involved in delivering the ESC IMRO program as currently designed.

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The Study should draw on the analysis previously undertaken by the ESC for the current IMRO program and, in light of the most recent information on meter and non-meter communications technologies, user responses, etc, clarify the extent to which the ESC's analysis can be adopted as a "baseline" for the current Study. The Study should also review IMRO programs and trials currently under development or implementation in other jurisdictions, including Ontario, California, Italy and UK.

In performing the analysis, it is anticipated that the Study will build upon existing work as much as possible, rather than undertaking new research.

The Study should identify relevant legal, regulatory, policy and commercial issues associated with introducing the preferred options for enhanced communications functionality. This would include potential impediments associated with existing regulatory decisions, the extent to which material changes to existing retail tariff structures would be necessary to elicit customer responses, and whether substantial enhancements to consumer information would be required.

Appropriate consultation with market participants and potential vendors should be undertaken on relevant aspects of the Study.

## 5. STUDY ADMINISTRATION

It is proposed that the Study will be conducted over a period of 3 months, and that a report on its findings will be presented to a meeting of the industry sponsors by the end of August 2005.

The Sponsors of the Study are the following network businesses:

- AGL, CitiPower, Powercor, TXU and United Energy;

the following retail businesses:

- AGL, Country Energy, Energy Australia, Origin Energy, Powerdirect, Red Energy, TXU, and Victoria Electricity;

and the Department of Infrastructure.

The ESC will be an observer.

A consultant will be commissioned by DOI on behalf of the sponsors.

One representative of each Sponsor will form a committee to steer the Study. The "Steering Committee" will be chaired by DOI.

DOI

18 May 2005