TASMAN ASIA PACIFIC

&

PACIFIC ECONOMICS GROUP

POTENTIAL FOR IMPROVEMENT IN BEST PRACTICE IN ELECTRICITY DISTRIBUTION

PAPER PREPARED FOR THE QUEENSLAND COMPETITION AUTHORITY

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CONTENTS

EXECUTIVE SUMMARY

The Queensland Competition Authority (QCA) has responsibility for the regulation of the tariffs charged by Queensland electricity distributors.

In fulfilling this role the QCA requires information on likely improvements in the efficiency of operations of electricity distribution over the regulatory period. To obtain this information the QCA commissioned Tasman Asia Pacific and Pacific Economics Group to provide estimates of the scope for improvements in efficiency in electricity distribution arising from:

- Adoption of known best practice in operating and maintenance costs; and
- Likely improvements in best practice operations and maintenance over time.

This paper presents the results of an analysis directed at estimating likely improvements in best practice over the next five years.

Best practice can be thought of as that combination of practices and procedures that allow a distributor to supply its demanded services at the lowest unit cost. To achieve this a distribution utility must be:

- Technically efficient; and
- Allocatively efficient.

Technical efficiency can be further broken down into an improvement in pure technical efficiency, a scale effect and a congestion effect. This study focused on measuring possible improvements in pure technical efficiency. That is, it excluded consideration of scale effects and congestion effects.

A survey was designed to collect information on possible improvements in pure technical efficiency and the impact such improvements could have on electricity distribution unit costs. The survey was sent to eight Australian electricity distribution utilities and the participation of overseas utilities was also sought. Three Australian utilities completed the questionnaire.

An analysis of the survey results suggests that pure technical efficiency improvements may generate small reductions in operation and maintenance unit costs over the next five years. Annual average reductions of around one per cent were indicated.

However, the number of survey respondents was low and respondents my have not fully appreciated what constitutes an improvement in best practice. There is thus uncertainty surrounding the estimates of the improvements in efficiency. This is sufficiently high to suggest that it would be inappropriate to incorporate the identified improvements in best practice in any unit cost target set during the current regulatory period.

1. INTRODUCTION

Tasman Asia Pacific (Tasman) and Pacific Economics Group (PEG) were contracted by the Queensland Competition Authority (QCA) to benchmark the operations and maintenance expenditure of the two Queensland electricity distribution businesses, ENERGEX and Ergon Energy (the DBs). This work involved:

- Estimating the scope for improvements in operations, given existing levels of technology knowledge; and
- Estimating the scope for further technological improvements, as represented by shifts in best practice, over the next five years.

This paper is directed at the latter issue. That is, estimating the scope for improvements in best practice, where this is defined as:

> "…the adoption of known equipment, techniques and practices which allow the level of desired operations to be undertaken at least cost, given prices faced by the business. Thus, an improvement in best practice would comprise the development of new equipment, techniques and/or practices which enable operations to be undertaken at a cost below what it would otherwise have been."

The following section outlines the general philosophy behind the requirement for information on shifts in best practice. This is followed in section 3 by an outline of the methodology and results. Section 4 concludes the paper.

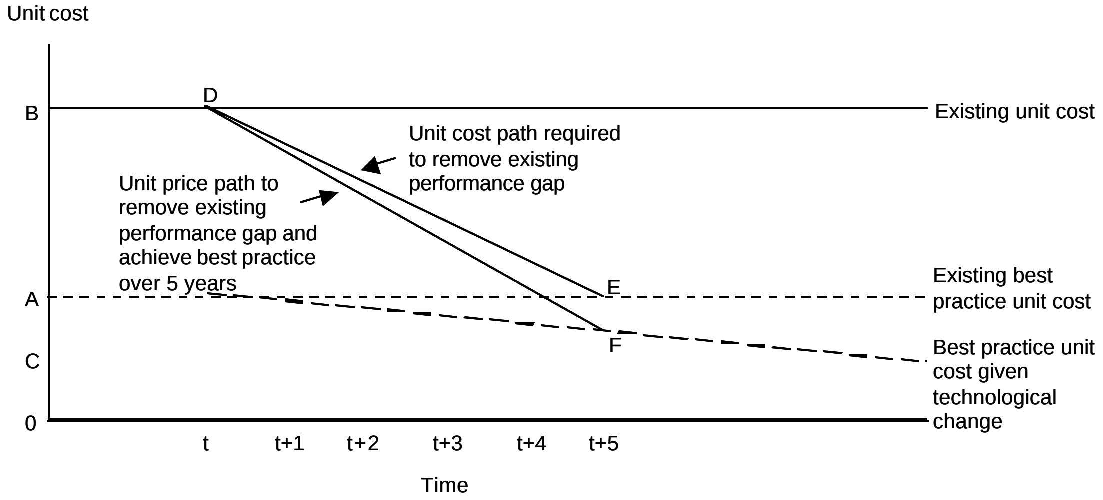
2. BACKGROUND

2.1 WHY IS INFORMATION ON BEST PRACTICE IMPROVEMENTS REQUIRED?

To understand why information on future improvements in best practice is required by the QCA, consider an organisation that currently does not employ best practices but expects to improve performance, say, over the next five years. During this period, technological changes may also take place which would also lower costs of operation for the business. Given this scenario, what would happen to the unit costs of the organisation over the next five years?

A hypothetical profile of unit costs is given in Figure 1. In this hypothetical case the organisation is not employing existing best practices and thus has unit costs of 0B which is above the existing best practice cost level of 0A. In addition, over, say, the next five years technological change is expected to lower unit costs to 0C.

Figure 1: **Time profile of unit costs for a hypothetical organisation moving towards best practice**



If this hypothetical firm was to achieve existing best practice over five years, its unit costs could fall according to the unit cost line DE in Figure 1. However, such a cut in unit costs would not achieve best practice because over the five years technological change has allowed unit costs to fall by the distance EF. Thus, if the organisation is to achieve best practice in five years it would need to follow the unit cost path DF. Thus, if the hypothetical firm wants to reach best practice over the next five years it will have to remove existing inefficiencies and also keep pace with the improvements in efficiency over the five year period.

Now, suppose this organisation is regulated and subject to price controls and the regulator requires that all efficiency improvements be passed on to consumers. The regulator would need to ensure that unit costs fell to 0C over the regulatory period. If it is to achieve this result it would need information on:

- the existing level of inefficiencies, that is, the distance 0B – 0A;
- the expected reduction in unit costs due to technological change, that is, the distance 0A – 0C; and
- information on the time required to achieve removal of inefficiencies. This would determine the unit cost paths (DE and DF in Figure 1).

While it is relatively easy to depict the removal of any inefficiencies and the capture of ongoing technical improvements, as was done in Figure 1, there are significant problems involved in implementing the concept. This was evident by comments received from participants in a survey designed to collect information on future technological change (see section 3). The point was made that benchmarking based on likely improvements in technical efficiency is “speculative and a magnet for dispute and controversy. It is not objective and does little to incentivise managers to perform”.

2.2 SOURCES OF IMPROVEMENTS IN EFFICIENCY

From an economic perspective, there are two types of efficiency:

1. technical efficiency which relates to producing maximum output from a given set of resources; and
2. allocative efficiency which relates to using the mix of inputs which has the potential to minimises cost, given prevailing prices.

If an organisation is both technically and allocatively efficient it is said to be “cost efficient”. That is, it produces its given output at least cost.

Following concepts developed in data envelopment analysis, technical efficiency can be further decomposed into:

- pure technical efficiency;
- scale efficiency; and
- congestion efficiency which measures the extent of any surplus inputs brought about by an inability to adjust input use (eg political constraints restricting the ability to remove surplus labour).

This study focuses on obtaining information on expected changes in pure technical efficiency. That is, it is directed at the issue of possible improvements in the technology of electricity distribution whose adoption would lower unit costs. Thus, reductions in unit costs arising from improvements in the scale of operations or improvement in economies of scope are excluded from the analysis.

3. METHODOLOGY AND RESULTS

3.1 A SURVEY

To obtain insights into the likely improvements in best practice a draft questionnaire was developed. The draft questionnaire was reviewed by John Blair, the team's expert electricity distribution engineer. In light of comments received the questionnaire was finalised and distributed to eight electricity utilities in Australia. Attachment A forms the questionnaire.

Attempts were also made to obtain the cooperation of electric utilities in the United Kingdom. These proved unsuccessful.

Distribution operations were split into the following areas:

- plant and equipment broken down into:
  - poles and wires; and
  - substations;
- system management broken down into:
  - software, hardware and equipment; and
  - fault restoration;
- system reliability;
- vegetation control;
- labour practices; and
- other.

Of the eight Australian utilities sent the questionnaire, three provided completed forms. This paper summarises the results obtained from the three completed returns.

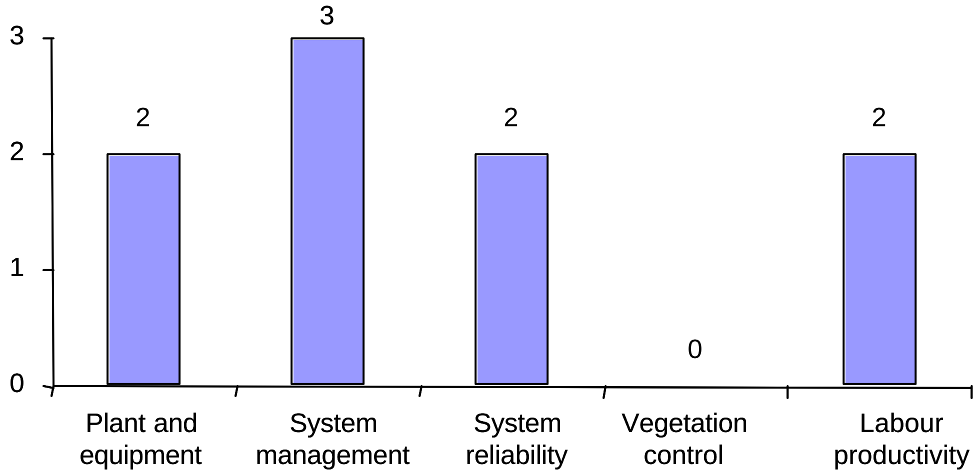
3.2 SURVEY RESULTS

The survey results are collated in Attachment B and are summarised in this section.

All respondents indicated that it was "most likely" that there would be an improvement in best practice over the next five years. Improvements were expected in all but one area nominated, that is, vegetation management.

System management was the only area where all respondents indicated they expected improvements in best practice (Figure 2).

Figure 2: **Areas of improvement in best practice** (number of positive responses)



The expected improvements in best practice were assessed as generating relatively modest annual savings. For example, improved system management was expected to lead to an annual 1.5 per cent reduction in loss over the next five years. Similarly, improvements in plant and equipment were expected to generate small reductions in construction costs. They would however, extend the economic lives of assets and improve reliability. Best practice improvements in these areas were expected to generate implausibly high annual improvements, on average, of around 10 per cent per year.

The major improvements in best practice identified are summarised in Table 1. A sizeable number of the efficiency improvements will only be attained through new capital expenditure. It may be rational to delay installation of this capital, given existing stocks of capital. Thus, it could be rational to have higher operations and maintenance costs than if the new capital was installed immediately. Thus, there are interdependencies between capital and operations and maintenance expenditure which makes it difficult to isolate “best practice” in one particular area at a particular point in time. This highlights the importance of comprehensive benchmarking when setting operation and maintenance targets — as was done in our previous work.

Table 1: **Sources of reductions in unit costs**

Area of improvement	*Source of improvement*
System management	
(a) software/hardware/equipment	
Utility 1	Integration of various systems to provide better and more timely decision making capabilities (i.e. cost efficient integration)
Utility 2	Asset management systems and support applications will help us more clearly identify areas requiring attention and focus expenditure on these areas
	Real time diagnostic systems will help identify trouble spots and enable preventative and predictive maintenance instead of catastrophic fixes
Utility 3	Fault prediction and analysis
	Load flow analysis
	Automated fault dispatch
	On line monitoring
(b) Fault restoration	
Utility 1	Automation and equipment technologies allowing for remote operations
Utility 2	System automation — allowing rapid restoration by remote switching to majority of customers
	Field base communications improvements
	Contracting out of some services
	Introduction of covered conductor, and maintenance free systems
Utility 3	Automated fault location
	Automated fault dispatch
	Retro fit of existing low reliability components
System reliability	
Utility 1	Asset maintenance practices — predictive failure, life cycle assessment, risk management techniques
	Live line practices
	Alternate supply arrangements and technologies
	Better understanding of assets condition - better asset condition monitoring and risk assessments
Utility 2	System automation — allowing rapid restoration by remote switching to majority of customers
	Field base communications improvements
	Introduction and extension of live line working
	Portable zone substations and distributed generation
Utility 3	Automated fault location and switching
	On line real time monitoring
	Improvements in asset condition monitoring
	Retro fit options for low reliability components

Table 1: **Sources of reductions in unit costs** (continued)

Area of improvement	*Source of improvement*
Vegetation control	
Utility 1	Effective clearance zones and cutting strategies/regimes
	Outsourcing full management to involve experts
	Tree management techniques
Utility 2	Better asset management and more targeted vegetation management will improve effectiveness though not necessarily cost — pay off should be improved reliability
Utility 3	No response
Labour productivity	
Utility 1	Process improvements
	IT – in particular IT use in field to office to field data/information transfer
Utility 2	Performance-based pay
	Contracting out
	Vehicle - base communications and on-board computing, allowing direct operation home to field
	Live line working
Utility 3	Further multi-skilling
	Work process improvements
	Amalgamation of similar "utility" tasks i.e. meter reading, connections, design, etc especially in a multi fuel environment
Other	
Utility 1	Risk management - predictive failure, risk management tools and techniques
	Knowing, determining, predicting condition of assets - e.g. collection, storage, analysis tools - remote communication, control of strategic equipment, assets
Utility 2	Modelling of system assets and providing development options will help optimise CAPEX
	Vehicle - office communications and dispersion of information to field operators plus GPS location of customers and resources etc.
Utility 3	Greater options to reduce uninsulated distribution components - lower faults costs
	Improvements in monitoring of system components - lower fault costs, lower asset management costs, more efficient use of capital funds

Returning to a discussion of the survey results, as outlined above, the estimated improvements were expected to generate small to modest improvements in efficiency over the next five years. However, many of the improvements listed in Table 2 are already in existence. It would thus seem that some of the identified improvements in best practice are in fact adoptions of existing technologies. If this is the case, the achievement of these improvements would be implicit in the operation and maintenance unit cost targets established by the QCA, based on benchmarking analysis.

Respondents were also asked to divide the total improvement in operations over the next five years into that due to the adoption of existing technologies and that due to an improvement in best practice. On average, about one third of improvements in performance were expected to be generated by improvements in best practice.

This result can be used to estimate the operating and maintenance savings expected from improvements in best practice. Recall that the QCA has proposed a target reduction in unit costs of two per cent and three per cent for ENERGEX and Ergon, respectively. These percentages were based, in part, on an analysis of the existing performance gaps of the DBs (see *Operations And Maintenance Cost Benchmarks For Queensland Electricity Distribution Businesses — Overview Of Findings,* report prepared for the Queensland Competition Authority, November 2000). They thus do not include improvements in best practice. In addition, we know from the survey results, that the improvement in best practice will account for roughly one third of all expected improvements in efficiency.

This information can be used to calculate the improvement in performance generated by shifts in best practice via the following very simple formulae:

(1) $A=\frac{B}{C}$

(2) $D=A-B$; where

A = total improvement in unit costs due to adoption of known best practice plus improvements in best practice;

B = improvements in unit cost due to the adoption of known best practice (based on the draft targets set by the QCA, simple average of 2.5 but rounded to two per cent here for simplicity);

C = share in the total improvement in unit costs due to the adoption of known best practice (here, from the survey results, assumed to be 0.67);

D = percentage improvement in unit cost due to improvements in best practice.

Feeding the above estimates for *A* and *B* into the simple formula it was calculated that improvements in best practice would reduce current operating and maintenance unit costs by around one per cent per year.

This "result" can be compared to the results for particular questions in the survey which asked for improvements in performance derived directly from improvements in best practice. For example, participants were asked to estimate the reduction in system loss that would result from improvements in best practice over the next five years. An average reduction of 1.5 per cent per year per utility was reported.

Caution should be exercised in the use of these estimates. They are derived from a small sample of electric utilities and it is not clear that respondents fully understood the distinction between adoption of known best practice and an improvement in best practice. Thus, it may be prudent to adopt a cautious approach to the survey results. In particular, more limited conclusions should be drawn, such as shifts towards existing best practice are probably the most important source of likely reductions in unit costs for electricity distribution utilities in Queensland in the next few years.

4. CONCLUSION

An attempt has been made to gain some insights into the likely reductions in unit costs in electricity distribution as a result of improvements in best practice over the next five years. Small gains are indicated.

However, it is suggested that the uncertainty surrounding the derivation of the estimates is sufficiently high to suggest that the estimates would be unreliable for use in a policy context.

ATTACHMENT A: SURVEY OF POTENTIAL FOR IMPROVEMENT IN BEST PRACTICE IN ELECTRICITY DISTRIBUTION

SURVEY PURPOSE

Tasman Asia Pacific has been contracted by the Queensland Competition Authority to benchmark operations and maintenance expenditure of Queensland electricity distribution businesses. This has involved, amongst other things, estimating:

- How far from existing best practice operations the distribution businesses are; and
- Possible improvements in best practice over the next five years.

This short questionnaire is designed to elicit the views of industry experts on the scope for improvements in best practice in electricity distribution over the next five years.

DEFINITION OF BEST PRACTICE

For this survey, best practice, is defined as the adoption of known equipment, techniques and practices which allow the level of desired operations to be undertaken at least cost, given prices faced by the business. Thus, an improvement in best practice would comprise the development of new equipment, techniques or practices which enable operations to be undertaken at a cost below what it would otherwise have been.

DEFINITION OF DISTRIBUTION

Data requested refers specifically to the pure distribution components of your business. We acknowledge that it is sometimes difficult to unambiguously identify the distribution network. However, we request you to include sub-transmission (50 to 150kV) and distribution (<50kV) lines and cables and to include all transformers other than those at the end of transmission lines (ie to include all transformers with primary winding less than 150kV). As a further guide, we note that distribution systems generally are operated radially, connecting transmission "demand points" to individual customers. You should include all inputs, outputs and other specified data associated with operating, maintaining, planning, designing and constructing this network. You should exclude any retailing, recoverable works, appliance retailing and metering services.

AUTHORITY/ORGANISATION CONTACT DETAILS

Name of Authority/Organisation:					
Operating Company/Organisation:					
	Name	Position	Telephone no.	Facsimile no.	E-mail address
Contact person regarding this survey:					
Address:					

1. Overall assessment of likelihood of an improvement in best-practice over the next five years.

Do you believe there will be an improvement in best practice over the next five years? (Please tick one box)

Not likely	☐	Possibly	☐	Most likely	☐	Highly probable	☐

2. Source of improvements in best practice

Which of the following areas are likely to exhibit improvements in best practice

Plant and equipment	☐	System management	☐	System reliability	☐	Vegetation control	☐	Labour practices	☐

3. Plant and equipment

3(a) Poles and wires

Are there any expected changes in the materials and/or construction techniques that would:

▪ Reduce construction costs	Yes	☐	No	☐	Estimate of reduction in costs (%)	☐
▪ Lead to longer economic lives for poles & wires	Yes	☐	No	☐	Estimate of increase in life (%)	☐
▪ Lead to reduced distribution losses	Yes	☐	No	☐	Estimate of reduction in distribution loss (%)	☐
▪ Improve reliability	Yes	☐	No	☐	Estimate of improvement in reliability (%)	☐

3(b) Substation

Are there any expected changes in the materials and/or construction techniques that would:

▪ Reduce construction costs	Yes	☐	No	☐	Estimate of reduction in costs (%)	☐
▪ Lead to longer economic lives for substations	Yes	☐	No	☐	Estimate of increase in life (%)	☐
▪ Lead to reduced distribution losses	Yes	☐	No	☐	Estimate of reduction in distribution loss (%)	☐
▪ Improve reliability	Yes	☐	No	☐	Estimate of improvement in reliability (%)	☐

4. System management

4(a) Software/hardware/equipment

Do you know of any new software/hardware/equipment that will enable system operations to be undertaken more efficiently in the next few years?	Yes	☐	No	☐

If yes, what is the software/hardware/equipment designed to do?

What reduction in loss will this software/hardware/equipment generate?	Per cent ☐

4(b) Fault restoration

Are fault restoration times/costs expected to improve over the next 5 years?	Yes	☐	No	☐
What proportion of this improvement will be due to an improvement in best practice?	Per cent			☐

Please detail major improvements in best practice that will drive these improvements

5. System reliability

Is system reliability, say as measured by SAIDI or SAIFI, expected to improve over the next 5 years? Yes ☐ No ☐

What proportion of this improvement will be due to an improvement in best practice? Per cent ☐

Please detail major improvements in best practice that will drive these improvements	

6. Vegetation control

Do you expect the cost of vegetation control to change significantly in the next 5 years? Yes ☐ No ☐

What proportion of this change would result from an improvement in best practice? *Per cent* ☐

Please detail major improvements in best practice that will drive these improvements	

What impact on vegetation control costs would you expect these changes to have? *Per cent of existing costs* ☐

7. Labour productivity

How would you expect labour use in electricity distribution to change, on a person per customer basis, over the next five years? (Please tick one box)

Improve ☐ Remain the same ☐ Deteriorate ☐

What will drive any improvements labour productivity? (Please tick one box)

Move to best practice ☐ Improvement in best practice ☐ Combination ☐

What, if any, are the likely improvements in best practice?

8. Other technological advances

Please describe any other advances in best practice you expect to occur over the next 5 years and the potential impact of these on distribution business costs.

9. Other comments

ATTACHMENT B: SURVEY RESULTS

Question 1: **Overall assessment of likelihood of an improvement in best-practice over the next five years**

	Not likely	*Possibly*	*Most likely*	*Highly probable*
Utility 1			1	
Utility 2			1	
Utility 3			1	
Total			3	

Question 2: **Source of improvements in best practice**

	Plant and equipment	*System management*	*System reliability*	*Vegetation control*	*Labour practices*
Utility 1	1	1	1		
Utility 2	1	1	1		1
Utility 3		1			1
Total responses	2	3	2	0	2

Question 3: **Plant and Equipment**

Question 3(a): Poles and wires

	Reduced construction costs		*Longer economic lives for poles and wires*		*Reduced distribution losses*		*Improved reliability*	
	Yes/No	*Per cent*	*Yes/No*	*Per cent*	*Yes/No*	*Per cent*	*Yes/No*	*Per cent*
Utility 1	N	0.00	Y	5.00	N	0.00	N	0.00
Utility 2	N	0.00	Y	20.00	N	0.00	Y	25.00
Utility 3	Y	5.00	Y	5.00	Y	5.00	Y	10.00
Average		1.67		10.00		1.67		11.67

Question 3(b): Substations

	Reduced construction costs		*Longer economic lives for substations*		*Reduced distribution losses*		*Improved reliability*	
	Yes/No	*Per cent*	*Yes/No*	*Per cent*	*Yes/No*	*Per cent*	*Yes/No*	*Per cent*
Utility 1	N	0.00	N	0.00	N	0.00	N	0.00
Utility 2	N	0.00	Y	10.00	N	0.00	Y	10.00
Utility 3	Y	10.00	Y	5.00	Y	2.50	Y	5.00
Average		3.33		5.00		0.83		5.00

Question 4: **System management**

Question 4(a): Software/hardware/equipment

	Do you know of any new software/hardware/equipment that will enable system operations to be undertaken more efficiently in the next few years?	*If yes, what is the software/hardware/equipment designed to do?*	*What reduction in loss will this software/hardware/equipment generate? (Per cent)*
Utility 1	Yes	Integration of various systems to provide better and more timely decision making capabilities (i.e. cost efficient integration)	5
Utility 2	Yes	Asset management systems and support applications will help us more clearly identify areas requiring attention and focus expenditure on these areas	
		Real time diagnostic systems will help identify trouble spots and enable preventative and predictive maintenance instead of catastrophic fixes	15
Utility 3	Yes	Fault prediction and analysis	
		Load flow analysis	
		Automated fault dispatch	
		On line monitoring	2.5
Average			7.5

Question 4(b): Fault restoration

	Are fault restoration times/costs expected to improve over the next 5 years?	*What proportion of this improvement will be due to an improvement in best practice? (Per cent)*	*Detail of major improvements in best practice that will drive these improvements*
Utility 1	Yes	10	Automation and equipment technologies allowing for remote operations
Utility 2	Yes	25	System automation — allowing rapid restoration by remote switching to majority of customers
			Field base communications improvements
			Contracting out of some services
			Introduction of covered conductor, and maintenance free systems
Utility 3	Yes	50	Automated fault location
			Automated fault dispatch
			Retro fit of existing low reliability components
Average		28	

Question 5: **System reliability**

	Is system reliability expected to improve over the next 5 years?	*What proportion of this improvement will be due to an improvement in best practice? (Per cent)*	*Detail of major improvements in best practice that will drive these improvements*
Utility 1	Yes	30	Asset maintenance practices — predictive failure, life cycle assessment, risk management techniques
			Live line practices
			Alternate supply arrangements and technologies
			Better understanding of assets condition - better asset condition monitoring and risk assessments
Utility 2	Yes	25	System automation — allowing rapid restoration by remote switching to majority of customers
			Field base communications improvements
			Introduction and extension of live line working
			Portable zone substations and distributed generation
Utility 3	Yes	50	Automated fault location and switching
			On line real time monitoring
			Improvements in asset condition monitoring
			Retro fit options for low reliability components
Average		35	

Question 6: **Vegetation control**

	Do you expect the cost of vegetation control to change significantly in the next 5 years?	*What proportion of this improvement will be due to an improvement in best practice? (Per cent)*	*Detail of major improvements in best practice that will drive these improvements*	*What impact on vegetation control costs would you expect these changes to have? (Per cent)*
Utility 1	Yes	20	Effective clearance zones and cutting strategies/regimes	20
			Outsourcing full management to involve experts	
			Tree management techniques	
Utility 2	No		Better asset management and more targeted vegetation management will improve effectiveness though not necessarily cost — pay off should be improved reliability	
Utility 3	No			
Average		6.66		

Question 7: **Labour productivity**

	How would you expect labour use in electricity distribution to change?			*What will drive any improvements labour productivity?*			*What are the likely improvements in best practice?*
	Improve	*Remain the same*	*Deteriorate*	*Move to best practice*	*Improvement in best practice*	*Combination*	
Utility 1			1		1		Process improvements
							IT – in particular IT use in field to office to field data/information transfer
Utility 2	1					1	Performance-based pay
							Contracting out
							Vehicle - base communications and on-board computing, allowing direct operation home to field
							Live line working
Utility 3	1			1			Further multi-skilling
							Work process improvements
							Amalgamation of similar "utility" tasks i.e. meter reading, connections, design, etc especially in a multi fuel environment
Total response	2	0	1	1	1	1	

Question 8: **Other technological advances**

	Other technological advances
Utility 1	Risk management - predictive failure, risk management tools and techniques
	Knowing, determining, predicting condition of assets - e.g. collection, storage, analysis tools - remote communication, control of strategic equipment, assets
Utility 2	Modelling of system assets and providing development options will help optimise CAPEX
	Vehicle - office communications and dispersion of information to field operators plus GPS location of customers and resources etc.
Utility 3	Greater options to reduce uninsulated distribution components - lower faults costs
	Improvements in monitoring of system components - lower fault costs, lower asset management costs, more efficient use of capital funds

Question 9: **Other comments**

	Other comments
Utility 1	None
Utility 2	Regulatory requirements from e.g. IPART, will force regulated businesses to improve reliability with potentially less money
Utility 3	None