26 April 2002

Mr Tom Parry
Chairman
IPART
PO Box Q290
QVB Post Office, NSW, 1230

Dear Tom,

Subject: Interim Report on Undergrounding of Electricity Cables in NSW

Thank you for your letter and a copy of the interim report on Undergrounding Electricity Cables in NSW.

We have reviewed your report as well as the Meritec report on benefits, costs and potential network designs. While we have some reservation concerning the conclusions in the Meritec report we support the conclusions that you have made regarding funding principles. Our comments on both are included with this letter. We will also email a soft copy to Michael Seery.

We look forward to working with your team to finalise the report. If you have any queries please contact me on 9269 2111.

Yours sincerely,

(PAUL A. BROAD)
Managing Director

IPART Interim Report on Electricity Undergrounding

April 2002

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IPART Report on Electricity Undergrounding

1. Introduction

EnergyAustralia welcomes IPART's Interim Report on Electricity Undergrounding as a serious attempt to quantify the costs and benefits, as well as outlining a reasonable approach to funding undergrounding in NSW.

It is important to note that the NSW electricity industry recognises the obvious benefits of undergrounding and has been pro-active, along with local councils and developers, in the undergrounding of electricity assets in new developments over the last three decades. In EnergyAustralia's case this has resulted in 23% of LV mains and 36% of HV mains being placed underground.

In relation to the Interim Report, we believe that there are issues with the interpretation of the costing methodology used by the consultants. We would like to work with IPART in resolving these issues prior to the release of the Final Report. These issues and issues relating to the Meritec methodology are dealt with in more detail later in the report.

2. Funding Options

Despite concerns on the costing issue, the Interim Report clearly indicates that the costs associated with undergrounding outweigh the benefits. We support the "beneficiary pays" principle adopted by IPART in its report, as it is the most efficient and equitable means of allocating costs to members of the community who are deriving benefits (via improved amenity, reliability, and property values).

We also strongly support IPART's proposal that local communities be given the choice as to whether they underground their electricity networks. Local communities that place a relatively low value on the local benefits of undergrounding be given the choice of opting out.

We believe that a great deal more information is required about the community's demands for improved levels of network services before a decision can be made on behalf of consumers to make a significant investment in undergrounding electricity networks. In order to address this the NSW Distributors are jointly funding a major study into the demand for network services aimed at providing information on the relative value and importance customers' place on the attributes of electricity network services. This will provide a useful basis upon which to establish priorities for improving the standard of electricity network services.

We support the mixed funding approach recommended by IPART as a practical scheme that comes closest to meeting the equity requirement. The predominant use of Council rates or local levies to raise funds is the most efficient means of capturing local amenity benefits and reflecting a beneficiary pays scheme. The positive attributes of the major funding coming via local councils is that the local community would have greater influence on the extent of undergrounding in their area, offering a greater link to Willingness to Pay.

The estimated 40-year timeframe referred to in the report is realistic however, this timeframe should be linked and tested against community expectations and Willingness to Pay.

The development and implementation of a formal undergrounding program needs to be supported by a clearly defined set of principles and a transparent review process. In particular, this approach would need to recognise that different stakeholders will desire different outcomes that need to be balanced in the interests of an optimum outcome for the community and the performance of the electricity network. We will work closely with local Councils, given their close links with local communities, in developing undergrounding projects that have broad support.

Meritec Report on Costs, Benefits and Network Design

1. Introduction

Meritec raises a valid issue in their report and we agree that if a widespread undergrounding scheme is to start then we should review the planning concepts and designs for the scheme. The assumptions on which a review of the network design, including the desired outcomes need to be carefully debated and agreed before any design work can commence.

The work by Meritec is valid to the extent that it raises the design issues and presents one solution. We do not agree that the assumptions on which the proposed design is based are valid. There are some fundamental flaws in both the assumptions and results of the model, in particular the probable costs.

The community has expressed a desire that undergrounding should occur essentially to improve the built environment and supply reliability.

Previous EnergyAustralia undergrounding schemes were aimed at improving reliability in areas where there will be the most impact. The focus has been on undergrounding high voltage distribution networks as this work results in a widespread improvement in reliability rather than a localised impact that would be achieved with undergrounding low voltage networks. This probably does not resolve the visual impact of overhead networks but does provide some improvements for the community as removing high voltage poles does reduces the impact of vegetation management as overall pole height is reduced.

We have also participated in many undergrounding projects for commercial districts. Most projects were initiated by local council projects.

We have some comments on the assumptions used in the Meritec report as well as the results. These are under the headings used in the report.

2. Transmission Networks

Undergrounding schemes must consider the transmission and sub transmission networks as the routes do include suburban streets and the communities that decide to be part of an undergrounding scheme will expect these overhead wires to be removed so that all poles and wires are removed. Leaving 33kV and higher overhead assets will cause resentment towards the scheme as the poles are higher and this means that they are more visible and require greater vegetation management. The schemes will be seen to have failed to achieve the necessary results.

The transmission and subtransmission networks in the EnergyAustralia supply network are based on 33kV, 66kV and 132kV system voltages. The move to 132kV reflects not only technology improvements but increasing load density. In the inner urban areas of Sydney 33kV networks no longer support the load density and 132kV is the only viable option. High load densities demand that we achieve the best economies of scale by installing high capacity supply points for the distribution network.

In more rural areas 33kV and 66kV are used and this reflects the fact that these supplies are available and the cost to provide 132kV supply for small loads would be generally much higher and is not justified.

Studies done some years ago by EnergyAustralia indicated a broad optimum range but changes to sub transmission connections such as conversion from 33kV to 132kV do change the cost structures.

There is also some evidence that there is a trend towards HV customer connections. The number of connections to the 11kV distribution network is growing faster than the overall load growth. This is reflective of higher individual load requirements than has been observed in the past ie larger developments. The number of 33kV customer connections although small is also growing. This is reflective of increasing numbers of applications for loads of more than 10MVA.

3. *Optimum Network Design*

The optimised network proposed by Meritec requires that Undergrounding and the associated optimisation be carried out in a continuing program over a relatively large area. This is necessary to

- Allow sufficient new 22kV capacity to provide support to the proposed single transformer zones during outages
- Provide a new network with adequate connectivity within the 22kV distribution network, given the cost and difficulty in providing interconnection to the existing 11kV system.

The above requirements would make it difficult to achieve IPART's aim to provide local communities with the choice as to whether they underground their electricity networks. Whilst undergrounding will undoubtly provide opportunities to optimise the existing network, it is important that any process adopted allows sections of the community who do not want or cannot afford undergrounding to opt out of the program. Meritiec's proposed optimisation would not allow this to occur.

The existing network design is optimised within the constraints of geographical factors, load growth and the built environment. Simplistic, homogeneous greenfields models can be misleading. Geographic factors include rivers, main road and rail networks. As network load increases opportunities are taken to evaluate optimum zone substations and either relocate or rebuild.

Meritec comment that undergrounding can be achieved by undergrounding existing networks as they reach the end of their life. The age of the EnergyAustralia network varies throughout the network. There are few segments where bulk replacements, particularly of overhead networks will be needed. Replacement is progressive due to failure/aging of individual components or the changing pattern of load growth. New segments are added to support new "spot loads" and well as to support general load growth.

Given the wide variation of a equipment ages within an area the requirement to carry out an undergrounding program over an extensive area will result in the premature retirement of much of the equipment within the selected area adding substantially to the real cost of the program.

Network designs are aimed to produce cost effective outcomes as we see this as a stakeholder expectation and IPART do consider that capital expenditure should be prudent. If future network growth is to be taken into account for an undergrounding scheme then the definition of prudent expenditure needs to be developed to include this allowance.

4. *11kV to 22kV Conversion*

The question of using 22kV for high voltage distribution instead of 11kV will be the cause of many debates. With hindsight 22kV may have been a better option. In some cases however costs will be higher to rollout a replacement 22kV network. We do agree that an isolated greenfield development could use 22kV. Where greenfield development adjoin the existing 11kV system the potential cost savings arising from the use of 22kV infrastructure are outweighed by the disadvantages of not being able to interconnect the fledgling 22kV system with the established 11kV system. .

We would expect that the change to 22kV would result in a decrease in distribution mains of about 50% just from the voltage change. This would necessarily mean a 50% change in cost. One of the determining factors in the location of distribution substations is the length of low voltage mains and allowable voltage drop. The location of customers is a major determining factor in the low voltage network costs.

If a large scale 22kV conversion was started then the requirement for support by interconnection of the new 22kV network to several adjacent zones (for transformer outages) will require a widespread conversion over a large area as 11kV networks cannot provide this function. This may not align with the IPART requirement that communities be given the option to be part of the scheme or opt out. This in turn would defeat the aim to develop an optimum design if a mixed 11kV and 22kV network was to develop. One option would be provide excess capacity in the new zone substations to allow for outages which would defeat the purpose of the optimisation.. Within the NSW regulatory regime it would be necessary to demonstrate that this excess capacity is effective.

In the EnergyAustralia supply area much of the high voltage distribution network is already underground. To replace this network with a 22kV network will require that we scrap the cable network assets part way through their life. The replacement cost of these assets is $1600 million. We will also need to scrap distribution substations that have a value of $1,000 million and rebuild many zone substations. The high value of the above assets is reflective of the fact that a large percentage of EnergyAustralia’s existing 11kV network is already underground and that most of the existing substation assets could not be used to supply load at 22kV.

5. Undergrounding Schemes for Main Roads

The Meritec report recommends that undergrounding schemes for main roads be avoided. Main roads are well travelled by commuters and overhead networks are very visible, particularly when the main road is part of a commercial district. This is reflected in the recent work by many Sydney councils to underground commercial districts.

There are many maintenance restrictions for main roads including notifications to stakeholders and working hour restrictions.

Poles for overhead networks along main roads are generally close to the kerb and so are easily damaged by passing trucks as well as high loads. Awnings outside shops also impact the location of poles and are a safety hazard as they provide access to the overhead mains.

These issues suggest that undergrounding along main roads may provide many benefits including reliability, ease of access for trucks and visual improvements.

It should be noted that the load density along main roads may be higher than surrounding areas. In many cases HV feeders may need to run along or parallel to main roads to service this load.

6. Zone Substation Designs

Supply reliability with single transformer zone substations also needs to be debated. Zone substations in the EnergyAustralia network have been designed essentially with an n-1 reliability criteria. If a zone transformer or subtransmission supply fails then there is an alternative available and the switching is in most cases automatic. The supply interruption is very short. Distribution network high voltage cable outages do not impact the availability of alternate supply. The Meritec proposal suggests that single transformer zone substations be used. The cost to provide automatic switching for outages has not been costed in the proposal. If the switching is manual the perceived increase in reliability may be lost. In addition the alternate supply depends on the high voltage distribution network. Any network outages will reduce the ability of the network to support a zone substation outage.

Cost efficient use of a single transformer design assumes that a zone load can be shared between other zone substations during transformer or feeder outages. In an optimum case this means that the load of each zone would be split between the surrounding zones (six in the case of the Meritec suggestion). The available firm capacity from a zone substation is limited by the transfer capacity available to other zones and this in turn is restricted by the number and rating of interconnecting feeders. This works well in theory for centrally located zones in areas of reasonably homogenous load, however it does not work well for areas with large variations in load density or which are have limited connectivity to other zones due either to geographic or other boundaries such as differing supply voltages.

The single transformer designs in the Meritec report, with 6 x 22kV feeders has a load limit of less than 50MVA if spare capacity is allowed for. This is less than 50% of the capacity of EnergyAustralia's existing suburban designs.

Adoption of the Meritec philosophy would thus see an increase in the overall number of zone substations in areas of high load density, with corresponding increases in the land and building costs.

It is unclear whether Meritec have adequately allowed for land or substation establishment /construction costs in their model. The incremental land or building costs associated with moving from one to three transformers are less than the costs of establishing an additional substation..

Whilst single transformer zone substations could be used for areas where a costly ultimate development can be deferred, provision for ultimate development to a multi transformer substation should be included in the design.

In summary, single transformer zone substations are an option. However we believe that a larger zone substation , providing a high capacity supply point, is a better option given the pressures on utilities when finding substation sites.

7. Zone Substation Locations

The issue of zone substation locations has been debated many times. While defining an optimum location for network load is possible finding an appropriate site in not. Potential sites for zone substations are increasing difficult to find. Restrictions on substation sites include ;

- 132kv cable access to the site
- 11kV (or 22kV) cable access to the site and the surrounding network.
- Community and local council consultation.
- Assessment of environmental factors
- Heavy equipment access for transformer deliveries.
- Cost of the site.
- Availability of suitable sites

The model proposed by Meritec suggests that many more zone substation sties are required for smaller zone substations. Finding the sites in the Sydney region will not be easy or low cost. Community consultation and rejection of optimum sites must be included in the models. The model also ignores differential load density and requirements driven by dominant customers.

The approval process for such a scheme also deserves consideration. New Zone substation sites will require community acceptance and local council development consent. This may well prevent the establishment of zone substations in some localities stopping zone substations from being optimally distributed from a geographic or load perspective..This problem is further exacerbated by the issue that the need to maintain supply whilst 22kV conversion is carried out will require the establishment of new zone substations (on new sites) before the old installations can be retired.

Some discussion on 132kV cable routes is also necessary. 132kV cable routes are generally designed as a unit. Crossbonding and sheath earthing issues limit the possibility to split the cables into sections making the connection of new zone substations along a feeder impractical unless future sites are known and allowed for during the cable route design.

8. Cable Installation Costs

The models consider the construction costs for a scheme but seem to ignore the ancilliary costs for:-

- Community consultation
- Environmental impact assessments
- Development applications and consents for new distribution substation and zone substation sites.
- The availability and costs of suitable sites. Costs do increase for non optimum sites. Funding mechanisms proposed by IPART suggest that local councils contribute 80% of the cost. It may be that this gives the communities an incentive to find suitable locations to minimise costs.

9. Meritec Load Models.

The modelled costs for the undergrounding scheme are based on a load density. This in turn is based on customer density. The base figure for high density areas with a load density of 10MVA per 3,300 customers suggests that on average each customer has a demand of 3.0 kVA. For the areas where there are 2,000 customers per sq km the customer demand is, on average, 2.5 kVA. Our planning engineers use between 3.5- 4.5 kVA for customers with no air conditioning and 7kVA per customer with air conditioning based on real experience in EnergyAustralia's supply area.

Based on air conditioning appliance sales we estimate that approximately 43% of customers have installed an air conditioner. Air conditioner load is approximately 2.4kVA per unit and they generally operate in peak periods (summer and winter). We also anticipate that by 2012 approximately 60% of customers will have air conditioning installed.

Urban consolidation in Sydney where 2 villa homes are replacing a existing free standing home will also concentrate load in smaller areas, particularly along major transport routes.

This suggests that the basic assumptions for network loads now and into the future are too low. The models need to consider higher load densities and the impact this will have on construction costs. It should be noted that average demand per head of population increased 5 fold between 1950 and 2000.