REVIEW OF TRANSMISSION PRICING FOR ELECTRICITY

BY STEPHEN P KING

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FOREWORD

The Tribunal commissioned this paper by Dr Stephen King of the Research School for the Social Sciences at the ANU to assist in its consideration of the regulation of the electricity transmission network in NSW.

Transmission pricing can be a difficult and technically complex subject. One area of common agreement is that there are few suitable models in place overseas. The primary focus of the report is on the proposals developed for cost reflective network pricing (CRNP) under the auspices of the NGMC. In examining the link between asset valuation and pricing, the paper notes that the deprival value methodology underpinning CRNP provides an economic basis for valuing existing assets. However Dr King goes on to express concern that the recovery of sunk asset costs through pricing may not provide the most appropriate economic signals.

The issues raised in this report are complex and a range of views exist. The Tribunal hopes that this report will prompt further discussion of the issues surrounding the regulation of the prices for access to the transmission system.

The Tribunal recognises that there is considerable support within the electricity industry for the adoption of CRNP. Despite this, significant debate about its merits remains. The Tribunal is reluctant to endorse the application of CRNP to the calculation of charges for the use of the transmission network to individual bulk supply points. The approach results in significant differences in prices between supply points in the network which could affect customer charges. Particular concerns are the complexity of the approach, the doubts surrounding the economic merits of the price signals provided and the potential impacts on customers.

In the light of these concerns, the Tribunal proposes to set prices for the use of the high voltage transmission system on the basis of the average of the CRNP estimates for the bulk supply points within a distributor's region. Within a distributor's area the charge for the use of the high voltage transmission system will be uniform but these charges will vary between distributors. The Tribunal believes this leaves open the option of a more extensive adoption of the CRNP approach should that be generally endorsed. However, it does not introduce substantial variations in transmission charges which would be difficult to unwind should an alternative approach receive support.

Thomas G Parry
Chairman

Sydney
December 1995

Review of Transmission pricing for Electricity

Stephen P. King.
October 25, 1995.

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1 Background

This report considers the asset valuation, pricing and regulatory schemes pro- posed by the National Grid Management Council (NGMC). The interconnected electricity grid between New South Wales, Victoria and South Australia is planned to commence operation in July 1996. The rules governing the prices that can be charged by the owners of monopoly transmission and distribution grids will be fundamental to the success of the tri-state electricity market. Consistency between the various state regimes will also be crucial. At present, it is anticipated that there will be a set of posted prices for access to the relevant grids which will underpin spot and forward markets for electricity as well as long term contractual relationships. Under the NGMC proposal, transmission and distribution prices will be based on a "cost reflective network pricing" procedure. These prices may vary, for example, by location and load. It may also be possible for prices to be altered by negotiation.

Section 2 will consider the asset valuation scheme that forms the major part of the NGMC proposals. Section 3 considers desirable forms of pricing. Section 4 considers the issue of investment. Section 5 considers the regulatory structures suggested by the NGMC to accompany their pricing scheme. Section 6 then briefly considers the issue of price setting by the network owners.

2 Asset Valuation and Pricing

The NGMC has spent considerable time developing a valuation scheme for network assets. The scheme is based on deprival value -"estimating the minimum loss that the [network] business would incur if it was deprived of the asset. ...Deprival Value is the lower of the optimised replacement cost of an asset and its economic value to the business" (Valuation of Transmission Assets, (VTA) p8). The asset values, together with variable costs of operation, will be used to calculate an annual network revenue requirement. To transform the stock valuation of assets into an annual revenue flow, a "weighted average cost of capital" is used (VTA p6 and Principles for Network Pricing (PNP) p11). The revenue requirement will be allocated to "individual network elements by apportioning the total network revenue requirements to individual assets on the basis of their replacement value in the deprival valuation of the network" (PNP p27). Allocation will depend upon the degree to which the relevant assets are common or specific. For example, " [c]osts which provide common good will be charged by a Common Service Charge. ...The Common Service Charge will be charged through a variable based price...and will be the same for all customers regardless of location" (PNP p28). The revenue allocations are transformed into network prices by "individual network owners (in conjunction with the Regulator/s) ...providing they are consistent with the objectives noted above" (PNP p31). "The prices will be published in advance allowing all users to participate in the energy market with complete knowledge of the network prices" (PNP p7).

Cost Reflective Network Pricing is intended to "mimic the outcomes of perfectly competitive markets" (VTA p6) so that the "asset values will reflect the long run marginal cost of efficient new entrants" (VTA p4). While obvious practical limitations will prevent deprival value measurements from being perfect, the methodology does provide a sensible economic basis for valuing existing assets. In particular, basing valuations on an "optimised" network will help prevent regulatory abuse that may arise when asset valuations are converted into revenue constraints by the rate-of-return procedure.

A key aim of the CRNP process is to establish a regime which will transmit the correct signals for future investment in network infrastructure. "Network charges...should in principle be cost reflective. This is to facilitate the competitive market, by providing equitable access to the network and ensuring that appropriate investment in the network takes place in the longer term" (PNP p1).

While this is a laudable aim, the application of CRNP is to current assets. These assets may be associated with costs that are either sunk and fixed; fixed for a specific time period; or variable with electricity transmission volumes. The vast bulk of the network costs are sunk. In other words these costs do not vary with the flow of electricity and are associated with assets which have no economically viable alternative use outside their current specific use as part of the network. The opportunity cost of the capital used in the construction of the transmission and distribution grids, to a large degree, is sunk.[1]

Evaluating sunk costs and attempting to transform these into prices may be a useful theoretical exercise but has little if any economic benefit. As these costs are sunk, any attempt to "recover" them must reflect political rather than economic imperatives. This is particularly the case where the relevant assets are owned by government business enterprises. While it is necessary to establish a regime of transmission prices that induces a desirable level of ongoing investment, such a regime needs to be divorced from the valuation of existing sunk costs.

At best, the allocation of sunk costs into transmission prices will be benign. If sunk costs are "recovered" through fixed charges (ie: unrelated to the volume of transmission services used) to network users and these charges do not lead any potential or existing user to cease to use the services of the network, then the charges will only result in a transfer from customers to the network owners. However, if the fixed charges cause some users, for example, to substitute to alternative fuels, or if the charges affect the marginal price of electricity transmission and distribution, then the process of "recovering" the sunk costs will lead to both an economically wasteful reduction in the transmission and distribution of electricity, and inefficient substitution towards technologies such as embedded generation that minimise transmission and distribution charges.[2]

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[1] A sunk cost or sunk expenditure refers to the expenditure on a factor which has no economic value other than in its current production use. Specifically, the opportunity cost of continued use of a factor whose expenditure is sunk is zero. In contrast, a fixed cost can be avoided by simply ceasing production, but the cost or expenditure does not depend upon the quantity of production so long as some production occurs. The use of these terms is not universal. For example, what I refer to as a sunk cost is referred to as a fixed cost by Varian ("Intermediate Microeconomics" 1993). Varian uses the term quasi-fixed cost where I use the term fixed cost. However, my use of the terms is standard in Australia.

[2] This is not to claim that embedded generation is inefficient. Rather, setting marginal prices above marginal cost will lead to more substitution towards embedded generation and other technologies that minimise the use of transmission and distribution than would be desirable at first-best prices.

As a valuation regime, the deprival method is a reasonable forward looking approach. However, establishing a price regime based on the CRNP of sunk costs is economically misguided. If there are politically imposed revenue constraints that need to be met beyond the avoidable costs of production, then these constraints should be made explicit. They should not be presented as a reflecting a process that mimics competitive markets. Importantly, these revenue constraints need to be separated from the incentives for future investment in the network.

3 Fixed and usage based charges

Fixed (but not sunk) and variable costs should be reflected in network prices to ensure optimal use of the relevant assets. For example, if there is a transmission asset that serves one particular customer which is necessary for any electricity transmission to that customer, but also has an alternative use, then the opportunity cost of using that asset is a fixed cost of serving the customer. The customer should bear this cost as an upfront charge over a relevant period of time.[3] If the customer's value of the use of the asset is not at least as high as the opportunity cost then the asset should be deployed to its alternative use. Similarly, any variable costs of transmission should be reflected in usage-sensitive customer prices.

If fixed costs are common over a group of customers then they should be allocated as fixed charges. However, it will generally be desirable to set different charges between customers. Setting each customer an equal share of the common fixed costs may lead some to substitute to alternative energy sources even though it is economically desirable to maintain their use of the network. However, this is clearly at odds with the aim that network pricing should be "non discriminatory" (PNP p1).

Optimal network prices will involve short-run marginal cost (SRMC) pricing based on volume, with fixed charges to recover both fixed costs and any additional imposed revenue requirements. In general the fixed charges will be location specific and may discriminate between similar customers. The variable charges may involve peak-load pricing at capacity. Alternatively, if there are well functioning spot markets for electricity, access can be rationed on a non-price basis with resale enabling those customers with the highest valuations to gain the (constrained) electricity supply. This could occur, for example, if there is a capacity constrained interconnector between two regions each with a well functioning spot market. While variable costs should be met through usage sensitive prices, part of these costs will involve line losses. Each customer should pay the marginal cost of their usage including any line losses that they impose on other customers. Otherwise, the relevant variable prices may lead to economically excessive use of the network.[4]

The NGMC proposals do not present a specific formula for translating revenue requirements into prices. Quite the converse, they state that "it is not appropriate or necessary to specify a precise pricing structure across the National Grid" (PNP p31). However, a number of statements suggest that a desirable pricing regime would involve usage prices in excess of short run marginal cost. For example, "[t]he application of usage based network prices is desirable to signal the effect of a participant's use of the network on the cost of providing the

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[3] I am using the term "customer" to mean any person or firm buying transmission services. The customer, for example, may be a generator.

[4] To the degree that marginal line losses cannot be easily measured it may be necessary to charge for these losses on an averaged basis in practice. See "Empowering the market: National electricity reform for Australia", p17.

network in the future. Prices need to be based on the factors that drive new investment in the network" (PNP p12). This suggests that appropriate prices would be based on long run marginal cost (LRMC). As noted above, this is used to justify the CRNP methodology.

The problems associated with new investment are discussed below. However, an immediate problem with LRMC based usage charges is that they distort the signals that face the customers. In particular, LRMC pricing will tend to over price the network compared to the economic cost of use. This is obvious when the network is not constrained so that the economically efficient usage price is SRMC. Further, for LRMC pricing to send the correct signals for network investment it must be carefully applied. The CRNP "revenue based" approach attempts to do this, but as noted above, it is based on sunk assets and may only roughly reflect true LRMC in practice. The NGMC proposals may, then, be interpreted as supporting a pricing structure that is potentially highly inefficient.

3.1 Sub-transmission and distribution pricing

The NGMC recommends the use of CRNP methods for both subtransmission and distribution. While the procedures for modelling subtransmission are simpler than for the EHV network, the same basic principles are recommended for both types of transmission (PNP p31). Similarly "[a]s with pricing for the transmission network, distribution pricing is a three stage process…

- Calculation of the overall network revenue requirement …
- The allocation of costs …
- Usage based prices …"

The comments presented in sections 2 and 3 apply equally to subtransmission and distribution. There needs to be a clear delineation between fixed and usage based charges on the basis of fixed and variable costs. Also, there needs to be an explicit statement of the reasons for attempting to retrieve sunk expenditures through current pricing. To the degree that marginal prices differ from marginal costs under the CRNP procedures, such pricing will lead to an inefficient use of resources.

4 Investment

4.1 Investment in new and upgraded network facilities that are not customer specific

The CRNP procedures establish a rate-of-return regime for new investment with the use of "optimised" delivery procedures to avoid owners manipulating the regime by artificially raising network capital requirements.

While this may appear to satisfy the criteria "that investment can take place in the network with a minimum of regulatory involvement" (PNP p7), the procedure differs little from one where the regulator directly decides which investment is justified and requires justifiable investment to occur subject to the investor receiving a set rate-of-return. The information requirements for the "optimisation" process are essentially the same as those required to determine the optimal investment in the first place.

The procedures for investment approval outlined by the NGMC are also rather cumbersome. "There needs to be a process by which all participants can be informed of potential new network investments" (PNP p16). While this would "not be an approval process" but "[r]ather, a consultation process" (PNP p16), it is likely that consultation would involve a requirement for at least a minimal degree of approval. New investment will result in higher prices, even for "participants who have made no change in their requirement for network service" (PNP p16). Consequently, any new investment, even if economically justifiable, may be met by considerable resistance.

There will inevitably be conflict between pricing for optimal short-term use of the network and using prices to "signal" economically desirable investment. If the network operator aims to maximise profits, either as a private operator or a corporatised government business enterprise, then any scheme which enables prices to rise to reflect the opportunity cost to consumers of congestion will be subject to profitable exploitation. In particular, it will pay a profit maximising network owner to have an undesirably congested system so that they can "skim" off the congestion rents. Conversely, if prices are not allowed to reflect these rents then they cannot adequately reflect investment opportunities.

The NGMC proposals are simply rate-of-return regulation subject to protection against unnecessary capital expansion. Investment will occur if the network owner can alter their prices to gain the set rate-of-return. "Optimisation" under regulatory review will avoid investment aimed solely at expanding the allowable rate base.

The NGMC proposal is a reasonable compromise for dealing with network investment. It should be tied into other procedures, such as allowing the network owner to offer products that differ according to quality (eg: guaranteed and interruptible access). The success of the regime will, however, depend crucially on the ability of the regulators to judge the validity of any new investment. At a minimum, this requires the regulators to know the true LRMC of investment together with the consumer valuations of that investment. The latter may be gained from spot prices for congested and different qualities of service. To the degree that the regulators do not know these values, the system will be open to abuse.

An optimal investment regime would allow for competitive provision of new network investment. This is unlikely to be practical in most situations. In this light, the NGMC proposals are reasonable but need to be monitored carefully to check for regulatory abuse and over capitalisation.

4.2 Investment in new and upgraded interconnectors

Before considering a pricing regime to elicit optimal levels of interconnector investment, it is first necessary to determine if these facilities involve natural monopoly technology. The possibility of new interconnector investment originating with third parties who "would develop [the new interconnector] in response to a perceived market opportunity" (PNP p18) is recognised by the NGMC. If such possibilities are likely to exist and are economically desirable, then it may be optimal to allow actual or potential interconnector competition to regulate access to this part of the network rather than including interconnectors in the general rate-of-return regulation. In particular, if competition between interconnectors is feasible, then simply allowing interconnectors to arbitrage between spot markets without regulatory intervention may elicit reasonable levels of investment. Differences in spot prices due to interconnector capacity constraints will lead outside investors or coalitions of customers to build new facilities. Such investment will be aided by the development of well

functioning spot and forward markets and will often involve long-term contracts with large volume customers.

The level of investment induced by interconnector competition need not be socially optimal. However, this represents an irrelevant comparison. What needs to be considered is whether competition between interconnectors will lead to a regime that is more efficient than one involving greater regulatory intervention.

If interconnectors are characterised by natural monopoly technology, then multiple interconnectors are economically undesirable and competition is unlikely to emerge. In such circumstances spot prices will continue to provide valuable information about desirable investment but, as with other network facilities, allowing network owners to gain congestion rents will not result in expanded investment. In this situation there would seem to be little to gain from treating interconnectors differently from other network elements.

The crucial issue in interconnector pricing is whether competition is either economically desirable or likely to emerge. The NGMC does not directly confront this issue but rather suggests two alternative regimes for new interconnectors.

To the degree that interconnector congestion and spot price differentials are unpredictable, there will be a demand for "insurance" against price risk. As with other commodity markets, this can be easily accommodated by the development of forward markets or institutions offering insurance. These need not be related to the interconnector regime directly, except to the degree that regulations must exist to prevent the owner of the interconnector manipulating these markets. However, as noted before, the prices in forward markets will provide important information to either regulatory authorities or potential new entrants. The NGMC proposals appear to tie spot price insurance into the general regulatory framework (PNP p17). I do not understand what these proposals are meant to achieve.

4.3 Investment in new generator facilities

Investment in new generator facilities will be guided by the prices that face these facilities. The pricing principles adopted by the NGMC are

- "Develop specific prices for each generator location (existing and potential) for the existing network which reflect the long run costs associated with their addition to the network ...
- The remainder of the network revenue requirement will be allocated to loads" (PNP p13-14).

"It is proposed that the same principles, based on the LRMC of network development, will be used for all embedded generators as those used for larger plant connected directly to the meshed EHV network" (PNP p14).

The effect of these principles will depend upon their practical interpretation. The correct pricing incentives for generation are simply based on a direct charge for any generator specific costs associated with connection to the grid, and pricing for load based on the (peak adjusted) SRMC of transmission. If increased load is placed onto the grid when it is congested then this will be reflected in the peak price. If it is optimal, given this new load, to expand the network, then this expansion will again be reflected in the peak prices on the expanded network. The generator bears the LRMC associated with their addition to the

network automatically through the prices. If any other generators are forced off the system by the rise in prices associated with the new generator then this merely reflects the optimal allocation of scarce transmission.

The NGMC principles appear to suggest a different approach to pricing. It is unclear from the principles whether the prices based on the "LRMC of network development" require that the new generator bear all the cost associated with network development for their load regardless of the effects of price rationing on the load of other generator facilities. Clearly such pricing could place a ridiculous burden on new generator facilities while protecting existing, potentially inefficient generators. If such pricing is not the intention of the principles then this should be made clear.

From the principles, it would also appear that revenue requirements relating to sunk costs would also be bourn on a load related basis. As argued above, "recovering" sunk costs in this fashion would be extremely detrimental to the optimal operation of the grid.

5 Regulation

"A revenue or price cap approach is recommended for the National Grid network prices. This approach offers stronger efficiency incentives and lower regulatory costs than a ROR [rate-of-return] approach" (PNP p20-21).

While I agree with the NGMC comments regarding price-caps and rate-of- return regulation, these differences are easily overstated. In particular, if CPI-X reviews are based on the operating costs of each particular network operator, the differences may be illusory. However, if CPI-X reviews are based on yard-stick comparisons between alternative network operators then CPI-X regulation can avoid some of the cost distortions associated with ROR regulation.

Care needs to be taken when designing a regulatory regime for network prices, to ensure consistency with the NGMC asset-return proposals. Price capping can be consistent with the NGMC restrictions on revenue. The price caps place a limit on the way the network operator can transform their allowable revenues into specific prices. However, care needs to be exercised to ensure that one layer of regulation does not make the other redundant; for example if the price caps are applied so tightly that no feasible prices can allow the network operator to recoup their allowable revenue.

The NGMC proposals mention revenue regulation. This form of regulation is supported by the NSW Government Pricing Tribunal (see Revenue regulation and electricity distributors, (RRED) 1995). The pricing tribunal supports this regulation as it "can break the link between revenue and sales volume" (RRED p2) which "discourages distributors from helping their customers to use electricity more efficiently" (RRED p3). "Revenue regulation and other methods to break the link between sales volume and revenue have been implemented in Northern Ireland, in England and Wales, and in some states of the US" (RRED p8).

The term "revenue regulation" is used to refer to a variety of regulatory regimes. For example, in the US average revenue regulation has been used as a way of implementing price-caps. The regulation applied to, for example, AT&T, involves a restriction on average revenue not to exceed a specific cap, where the revenue calculation is based on historic sales (see Sappington and Sibley, RAND Journal of Economics, 1992).

The form of revenue regulation suggested by the tribunal involves a movement away from sales based averaging. This can be achieved, for example, by capping the revenue (net of direct electricity costs) that a distribution company can earn, on the basis of the number of customers served as well as the volume of electricity sold. To the degree that distribution costs are, in fact, customer rather than volume based, such regulation will help remove any service bias that would be caused by setting simple price caps.

Care needs to be taken when implementing revenue caps. If the relative weights associated with, say, customer numbers and volume of sales, do not truly reflect relative costs, then there may be a bias in service mix. For example, a distribution company may have an incentive to gain a large customer base but only to sell relatively little electricity to each customer at a high per unit price. However, as the tribunal notes, when costs are customer as well as volume based, price caps will involve a bias towards high volume sales to a few customers. Because of this, it is likely that revenue regulation, as envisaged by the tribunal, will lead to considerably less distortion and an improvement in efficiency when compared to standard price caps.

The pricing tribunal has been using revenue regulation for the past two years (RRED p3). Their experience suggests that it can be an effective regulatory instrument when dealing with government utilities.

6 Price setting by network operators

As already noted, the NGMC proposals do not provide specific pricing rules. However, efficient pricing will require a correct "split" of prices between fixed and variable components. The rules governing such a split are outlined above.

The possibility of both "posted" and negotiated pricing is presented by the NGMC proposals. Negotiated pricing needs to be approached with some caution. If a network owner negotiates with a large customer who uses the transmission services for their own consumption or as an input to final goods production, then negotiation can be economically beneficial. By negotiating from the posted prices to a mutually more satisfactory arrangement, both the customer and the network owner can benefit.

Conversely, if a network owner negotiates pricing with a firm that uses transmission as an input into final sales of electricity, then both parties will have an incentive to try and undermine any alternative suppliers in that final market (who also require transmission access), gain monopoly power, and divide any monopoly rents. Such negotiation is potentially damaging from an economic perspective. As a result, there is no simple rule to deal with negotiated pricing.

It is necessary to consider the relationship between negotiated prices and the network owner's revenue constraints. If the network owner can "transfer" revenues between customers in a discriminatory fashion then it may be possible to manipulate the pricing regime to lock-out potential final market suppliers. In particular the network owner could lower prices to one group of users while raising them to another group. The network owner would find such manipulation beneficial if they can indirectly reap some of the monopoly rents generated in the final market.

If negotiated prices are subject to a restriction that they are non-discriminatory then such practices are ruled out. But so too are desirable forms of price discrimination. Under non-discrimination the eventual negotiated prices need not be identical between customers. Rather, each customer must prefer there own set of prices to that which are offered to any other customers. The system of prices that can evolve under such a scheme can be quite complex (see McAfee and Schwartz, American Economic Review, 1994).

There is little guidance under the NGMC proposals to lead network owners to implement efficient prices. It is far from clear that negotiations will significantly improve these incentives. Overall, it suggests that the network prices that evolve under the NGMC system are likely to be far from optimal.

Stephen P. King.
October 25, 1995.