HARVARD Kennedy School
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MEMORANDUM

DATE: May 31, 2018

TO: Carl Hansen, Electricity Authority, New Zealand

FROM: Bill Hogan

SUBJ: LRMC Pricing

As requested, I read the draft paper by Roger Proctor, "Nodal Prices and LRMC Charging," sent to me on May 17, 2018. In addition, I read some of the background material such as the "Issues to Consider in Designing an LRMC Pricing Regime," a report prepared for Transpower by Stephen Batstone, dated August 2017.

In broad strokes, I agree with the main conclusion of the Proctor analysis: "In summary, we have concluded that in most of the situations where we have considered the case for a LRMC charge, the case does not stand up."

The Proctor paper addresses many of the arguments and issues that appear in discussions of Long-Run Marginal Cost (LRMC) pricing, especially in the case of transmission. However, there is no explicit and general definition of exactly what is meant by LRMC here and how it would be implemented for a transmission system. When I asked for further details, the response was that the main elements of such a model appeared in the Batstone paper.

The Batstone paper emphasizes the lack of a perfect solution and the need to make tradeoffs in choosing the elements of LRMC pricing. Although written and presented as a pragmatic approach to designing and implementing such a regime, the Batstone analysis is very close to that of Proctor and I read it as more in the vein of: '*if you must*, here is how to design an LRMC pricing model without doing too much harm.' Proctor looks at the underlying arguments and concludes that the least harmful approach does not lead to the LRMC model in the case of transmission on an interconnected grid.

The problems of the LRMC story are fundamental. I would step back from the details of the analysis to emphasize three issues. First, the LRMC analysis typically adopts the relevant description of the transmission system is a single line between two points where the flow on the line is driven by the peak load at the destination. Second, the transmission expansion cost function is essentially well-enough-behaved to be approximated by an increasing marginal cost, e.g.

convex. Third, transmission customers are myopic and make their long-lasting investments in future consumption equipment based on the current price.

While these assumptions simplify the framework and almost dictate the need for something like LRMC pricing, the assumptions are not innocuous. If we abandon these assumptions to consider something closer to reality, then the case for LRMC falls away.

The most important lesson we have learned over the many years of studying restructured electricity markets is that the interactions in a complex, interconnected, high-voltage transmission grid have a first-order effect on operations and on the marginal cost of dispatch to meet load at any moment. This fact gives rise to the security-constrained, economic dispatch with nodal pricing as found in the New Zealand market design. Both in theory and in practice we know that stress on this system can occur under a variety of circumstances that have little or nothing to do with the peak load at any location or peak load on the system as a whole. It is easy to construct examples where high loads, which require even expensive generators to operate, can reduce the strain the transmission system. Often the intuition that guides the analysis of a single line is simply wrong in the case of an integrated grid. And using the single line analogy to assign transmission costs leads to perverse behavior. We have seen wasteful expenditures in Texas and (I am told) in New Zealand, where electricity customers are making costly investments to shift their load away from the system peak, and avoid transmission cost allocations, even though there is no transmission congestion at the time of the system peak.

The assumption that the transmission expansion cost function is well-behaved enough to allow marginal analysis to guide efficiency is both critical and wrong. As you know, in their early work Schweppe and his colleagues adopted this assumption and then showed that the congestion rents that appear in spot markets would be enough to provide the incentives for efficient transmission investment at the margin. However, Schweppe et al. did not show how to construct this cost function. A little reflection shows that the cost function is not so well-behaved. In fact, the cost function is in general not convex in important ways. For instance, the lumpiness and generally decreasing marginal costs of expansion create the very problem of underfunding through congestions rents that motivates the search for alternative pricing mechanisms. Hence, there is an inherent contradiction in making the efficiency arguments for LRMC based on marginal analysis precisely when the marginal analysis does not apply; or in making arguments for LRMC using assumptions which make LRMC unnecessary.

Finally, the assumption of myopic loads and one-part pricing seems unnecessary and wrong. It may be true for some customers, who may also tend to be price inelastic and therefore not much affected by the pricing model. But for large volumes at the margin, that could come from larger commercial and industrial loads, the myopic assumption seems too extreme. Furthermore, since LRMC as described would not eliminate connection charges and other sources of revenue, the simplicity of one-part pricing and marginal analysis is not available. Hence, rational cost-benefit analysis inevitably requires some forecasting of counterfactuals and estimates of the fixed and

variable components for future use of the grid. The real challenge is in providing information about the counterfactual and the likely future charges with and without the transmission expansion, rather than imposing on everyone the mandate to be myopic.

Improvements in the analysis and allocation of the costs and benefits to make better decisions and provide better information would be important. This is a separate subject under the general heading of "beneficiary pays" cost allocations that we have discussed. But the argument that LRMC is available as part of that package "does not stand up."