Toward a combined merchant-regulatory mechanism for electricity transmission expansion

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Abstract Electricity transmission pricing and transmission grid expansion have received increasing attention in recent years. There are two disparate approaches to transmission investment: one employs the theory based on long-run financial rights (LTFTR) to transmission (merchant approach), while the other is based on the incentive-regulation hypothesis (regulatory approach). In this paper we consider the elements that could combine the merchant and regulatory approaches in a setting with price-taking electricity generators and loads. The monopoly transmission firm (Tran-sco) is regulated through benchmark or price regulation to provide long-term investment incentives. The two-part tariff approach used can be analyzed analytically only for well-behaved cost and demand functions. We explore a series of simplified transmission grids to argue that in a variety of circumstances those functions could have reasonable economic properties. The results suggest directions for further research to explore the properties of the cost functions and implications for design of practical

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incentive mechanisms and the integration with merchant investment in organized markets with LTFTSRs.

**Keywords**  
Electricity transmission · Financial transmission rights · Incentive regulation · Loop-flow problem

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1 Introduction

The analysis of electricity markets often assumes that transmission capacity is fixed in contrast with its dynamic nature and interdependence with other electricity subsectors. Analysis of incentives for expanding the transmission network is challenging in part because equilibrium in the transmission market has to be coordinated with equilibrium in other markets such as the electricity spot market, bilateral contracts, and related ancillary services such as capacity reserves markets (see Stoft and Graves 2000; Wilson 2002). In addition, loop-flows imply that certain investments in transmission upgrades cause negative network effects on other transmission links, so that capacity is multidimensional. Moreover, the transmission capacity function can be discontinuous.

Electricity transmission pricing and transmission grid expansion have received increasing attention in recent years. Since electricity transmission is a very special service with unusual characteristics, the approaches have been largely tailor-made and not simply taken from the general economic literature or from the more specific but still general incentive regulation literature. An exception has been Vogelsang (2001), who postulated transmission cost and demand functions with fairly general properties and then adapted known regulatory adjustment processes to the electricity transmission problem. The main purpose of his approach is to deal with asymmetric information between Transco and regulator about cost and demand functions of transmission services. While the Transco is assumed to be perfectly informed, the regulator only knows basic functional properties. However, the properties of transmission cost and demand functions are little known but may differ materially from conventional functional forms. Hence the assumed cost and demand properties in Vogelsang (2001) may actually not hold for transmission companies (Transcos).

The electricity transmission network has attracted additional attention as a result of power outages notably the one of August 14, 2003, in Northeast US, which affected more than 20 million consumers and six control areas (Ontario, Quebec, Midwest, PJM, New England, and New York), and shut down 61,000 MW of generation capacity. Problems with coordination and capacity of transmission grids were

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1 Total network capacity might even decrease due to the addition of new capacity in certain transmission links. For an illustration, see Hogan (2002a).

2 For overviews of alternative approaches and debates, see Brunekreeft et al. (2005) and Stoft (2006). See also Martzoukos and Teplitz-Sembitzky (1992), Yu et al. (1999), Krellenstein (2004), Saphores et al. (2004), and Vajjhala and Fishbeck (2007).