

Long-term investment in electricity: a trade-off between co-ordination and competition?

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Abstract

The purpose of this paper is to survey the theoretical debate and the practical problems of long-term investment in electricity. It discusses fundamental aspects of investment in electricity such as the interdependencies between generation and grid investment, free-riding problems, and the investment signals of different network access regimes. Especially, the externalities that are created by the nature of electric flows pose severe problems for investment decisions. The way these externalities are internalised in the pricing scheme strongly influences where rents are collected and investment is profitable. Besides, the handling of the loop-flow phenomenon is crucial for the trade-off between co-ordination and competition in long-term investment in electricity.

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1. Introduction

During the summer of 2003, the public focus concentrated on the need for investment in new transmission and generation assets. The question was raised whether deregulated electricity markets could create sufficient investment incentives. In this paper, we discuss the possible trade-off between co-ordination and competition that might arise with the opening of the electricity markets. On the one hand, in order to introduce competition, a once fully vertically integrated industry was vertically separated into competitive elements (generation and sales) and regulated monopolistic elements (transmission and distribution). On the other hand, following the separation of generation and transmission responsibility, new challenges arose in ensuring co-ordination between the different new entities (power producers, network operators, traders, etc.) to guarantee electricity supply.

Different frameworks have been developed in theory and practice to address the problem of interaction between generation and transmission. In a perfect market environment, a pricing mechanism takes over the part of co-ordinating the actions of market participants since this provides the most efficient results. This is, in general, also the case for investment decisions. In the electricity industry, under vertical integration, one utility was able to jointly optimise generation, transmission operation, and investment. After deregulation, the decisions to invest in generation on the one hand and network infrastructure on the other hand are taken by separate firms, rather than one integrated utility.

While the integrated structure of the industry—traditionally in combination with a cost-of-service approach to regulation—has favoured over-investment in generation and transmission assets, now the problem of under-investment is discussed. In principal, new grid investment may be undertaken by the established network owner or by third parties (so-called merchant or market-based investment, cf. Joskow and Tirole, 2003). Merchant investors try to profit from scarce capacity between regions by building (DC) lines to skim rents.

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Table 1
Questions associated with investment in electricity

Issue	Generation	Transmission
Security of supply/ adequacy	“Security is the system’s ability to withstand sudden disturbances, while adequacy is the property of having enough capacity to remain secure almost all of the time”. (Stoft, 2002: p. 133) How much is “enough” capacity? Who knows best/decides? Is there a need for capacity markets? (cf. Oren, 2003)	Investment need and responsibility?
Regulation and distortion of transmission investment incentives	Danger of over- or under-investment induced by regulation. Due to distortions in transmission investments distributed generation may increase to bypass the transmission system.	(Partial) cost pass through mechanisms?
Market design and investment signals	Who knows where to invest? Depending on the market design, signals for investment in transmission may be provided for all market participants or only for the SO. Trade-off between investment in generation and transmission? Influencing the location of new units can decrease transmission congestion.	Merchant investment in transmission or investment by the transmission owner? Co-ordination of both?

This paper concentrates on investment in new lines¹ and the possibly resulting trade-offs between

1. investment in transmission and in generation, and
2. co-ordination and competition.

These topics are linked closely by the transport characteristics of electricity. This makes it more difficult to estimate the “right” amount of investment. In addition to the economic calculation of market participants, a regulatory framework tries to implement general interests such as security of supply and system reliability. Table 1 provides an overview of the problems connected with long-term investment in electricity.

Given the overview in Table 1, this paper focuses on market design and price mechanisms and their inherent investment signals. It neither explores the effect of a single regulatory mechanism as a revenue or price cap on investment incentives nor discusses the possible demand for security of supply which might enter the investment level (cf. Wild and Vaterlaus, 2003).

The contribution concentrates on investment in generation assets and transmission networks analysing information and co-ordination needs and what might be left to competition. Its primary aim is to explain the technical problems of transmitting electricity and their implications for investment decisions. Secondly, transmission pricing mechanisms and the resulting investment-incentive schemes are presented. The paper is organised as follows. With Section 2, possible impediments to transmission investment, especially the trade-off between generation and transmission investment, is analysed. Section 3 explains different effects on investment incentives of a usage fee aiming at short run efficiency. With the market design and especially the pricing mechanisms, long-term investment signals

should be provided. This focuses on the trade-off between co-ordinating elements in the market regime and competitive ones building primarily on pricing mechanisms. Section 4 concludes.

2. Possible impediments to transmission investment

In this section, several possible impediments to transmission investment are discussed. In addition to impediments closely related to the characteristics of the transport network itself, such as lumpiness, loop flows and interdependencies between investment in transmission and generation assets, the investment decision might be influenced by regulatory risk and public resistance.

2.1. Lumpiness of grid investments

Transmission lines are characterised by significant economies of scale leading to problems in cost recovery (cf. Baldick and Kahn, 1993). It follows that (merchant) transmission investment is only profitable if the discounted value of earnings from sales of new transmission capacity exceeds investment plus operation costs. Earnings from transmission will be the higher the more congestion occurs. Since investment in transmission capacity is characterised by significant fixed costs (fixed-step costs), new transmission lines typically eliminate congestion that used to be present in the corresponding part of the network. Because of this lumpiness of transmission investment, investment will only be profitable if the network constraint partly persists after investment. If congestion is fully eliminated, no congestion rent can be extracted from the network users to cover investment costs.

2.2. Loop flows

The physical laws of power flows and network conditions (e.g. constraints on certain lines) cause external-

¹ Maintenance and modernisation of the existing network and the associated incentives are not covered in this article.

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