

## **Modelling Electricity Privatization in the UK**

Erik R Larsen and Derek W Bunn  
London Business School  
Sussex Place, Regent's Park, London NW1 4SA, UK

### **Abstract**

There seem to be several advantages in using System Dynamics modelling to understand the behaviour of newly privatized industries. System Dynamics models can develop insights on the possible evolution of the industry from public to private ownership and from protected to competitive markets. The implications for business strategy and for the regulatory framework can be examined under various scenarios.

As part of the privatization of the UK electricity industry a spot market to clear the electricity market has been created. The main reason for the spot market is to set the half hourly price at which electricity is traded. A further aspect is that it allows the regulator to set incentives to increase or decrease the generating capacity according to what he believes is necessary in the long run. We have modelled capacity investment in this newly created industry on the basis of testing its theoretical design.

Our model focuses on how the long term development of capacity utilization is likely to evolve, how much influence the regulator will have under the current regulatory framework, and how this framework should be modified to give the regulator more influence on the market to prevent cycles of over and under capacity.

## Modelling Electricity Privatization in the UK

### Introduction

A system dynamics model was developed to help understand the implications of the government intended policy on the UK electricity industry, as initiated in 1990 when that old integrated utility (the CEGB) was broken up. We were interested specifically in the behaviour which the proposed structure and regulatory framework would create in the industry. This new structure was without precedent elsewhere. A simulation model was therefore selected as the most effective way to develop some useful insights. Furthermore, we decided early on that we were interested in the long term development of the industry capacity, which made it much easier to focus our model.

The resulting model is different from many recent system dynamics models which usually simulate mental models of a management team in a company or industry (Morecroft et al. 1991, Morecroft et al. 1991). The model presented here is intended to test a particular regulatory framework, i.e. the regulation of the UK electricity industry, assuming that the players behave in a relatively rational way. We are well aware that this assumed rational behaviour might not be the behaviour the companies in the industry choose to follow. However, if the regulatory framework does not produce a desirable behaviour for relatively well behaved players, one might expect that even more problems will emerge when the players do not follow what, for the aggregated industry, are well intended strategies.

The model does, however, have one feature in common with recent system dynamics models, its size. Whereas most previous models in the electricity sector have been large (Garaghty and Ford 1985, Ford et al. 1987) this model is relatively small (around 170 equations altogether but only 100 "active" equations with a large part of the structure replicated for the three different but related companies). Whilst this prevents us from making detailed studies of the industry, such as the effect of technology, distinction between base and peak load etc., the relatively simple model still serves its purpose as a tool for understanding the overall industry behaviour.

### Modelling Privatisation

Privatization has been the subject of much economic analysis in recent years. There are numerous papers discussing the advantages and disadvantages of privatisation and how it should be carried out. Here we shall consider three kinds of privatisation:

(i) Privatisation and reorganisation of whole countries e.g., eastern Europe and the CIS. System dynamics models should be of use in this process, modelling the whole economic system or at least a large part of it. There is a long tradition of system dynamics for dealing with macro-economic policy (Khalid, 1986, Forrester, 1977) and there are potential valuable insights from using system dynamics in this area.

(ii) Privatisation of existing publicly owned enterprises e.g. banks and large conglomerates (Italy; Elf in France). This is now happening over the most of western Europe, as well as in a number of third world countries. This kind of privatisation comes under the heading of "normal" dynamics, i.e. the kind of problem most system dynamics models have been dealing with: the firm in the market and the firm has to find the best strategy to compete in this market. The privatisation is generally accompanied by a major change in the market structure.

(iii) Privatisation of public utilities. These have been public owned monopolies before privatisation and after the privatisation are still heavily regulated, limiting the degree of free market participation. However, these privatisations may go beyond a simple change of ownership and involve the creation of more competitive markets as well. Examples of this can be found in the UK with

telecommunications, gas, water and electricity industries have been privatised; other countries are now in the process of following suit.

Here we will focus only on the third kind: the privatisation of public utilities. There is however, no doubt that a system dynamics approach might be useful in all three cases.

Looking at the privatisation of the public utilities we believe that system dynamics might have a significant contribution to make in helping to "design" the process of privatisation and especially the regulatory frameworks in which these privatised companies operate.

The main focus of economic models of market behaviour is on the price, capacity and advantages/disadvantages of a given number of companies in equilibrium. However it is reasonable to question whether the system will ever reach this theoretical equilibrium. This therefore leaves a void in trying to understand how a new market that has been designed for theoretical equilibrium behaviour, will operate in the short-term. System dynamics models, on the other hand, will be oriented towards understanding the transition from public to private ownership and the consequences of the regulatory framework in this transition. A typical system dynamic model will be able to show when this process starts to go wrong, showing the build up of pressure in the system which may eventually force a political change in the regulatory framework or the question way the new industry has been designed (eg the crisis in the coal and electricity industries in the UK in 1992/93). In this way a system dynamics analysis might help prevent some of these mistakes in the construction of the regulatory framework. Such an analysis might also help companies to understand how their behaviour influences the political system, and in this way prevent newly privatised companies from provoking unintended changes in the regulatory framework.

The model described below has been used to understand how the regulatory framework might be inadequate or ill designed even in an almost perfect world - i.e. a world where the players behave rationally. Recent years experience in the UK electricity industry shows that it is very unlikely that the companies will behave in this rational way. These indications of non-rational behaviour plus the "design problems" have already led to several threats from both the regulatory body and politicians to change the way the industry has been broken up or to make major changes in the regulatory framework (minor changes having already been made).

### **Background**

During 1990/91, electricity generation in England and Wales was fundamentally re-structured from a single public utility, the Central Electricity Generation Board (CEGB) and split into two privatized companies, National Power (NP) and PowerGen (PG), together with a public owned company Nuclear Electric which has kept all of the nuclear plant. The 12 regional distribution and supply companies were also privatized (now called RECs - Regional Electric Companies) and able to compete independently to buy power from all the generators. Furthermore, the National Grid Company (NGC) has taken over the transmission business, the responsibility for ensuring secure dispatching of generation and the operation of a daily 'power pool'.

The daily power-pool, operated by NGC, is the market place for buying and selling electricity. Although various contracts and options are set-up between generators and suppliers, these are just hedges against pool price fluctuations. In the long term the pool price is intended to give the incentive to investment in new capacity. This is meant to be achieved by the so-called 'capacity element' in the price that generators receive from the pool.

Every day generators submit offer prices for power available from each generating unit in their company for the following day. The NGC using their 24-hour-ahead demand forecast together with these offer prices, and a large-scale optimization model, produces a schedule for generating power in

**References**

Bunn, D.W. and E.R. Larsen (1992) 'Sensitivity of Reserve Margin to Factors Influencing Inv Behaviour in the Electricity market of England and Wales' *Energy Policy*, May, 420-429.

Bunn, D.W., E.R. Larsen, K. Vlahos (1993) 'Complementary Modelling Approaches for Ar Several Effects of Privatization on Electricity Investment', *Journal of the Operational R Society*, 44, 10, 957-971.

Bunn, D.W. and E.R. Larsen (1994) 'Assessment of the Uncertainty in Future UK El Investment Using an Industry Simulation Model', *Utilities Policy*, forthcoming.

Ford, A, M. Bull, R. Nail (1987) 'Bonneville's Conservation Policy Analysis Models', *Energy* 15, 2, 109-124.

Forrester. J.W. (1977) 'Growth Cycles', *De Economist*, 125 (4), 525-543.

Khalid, S. (1986) 'The Dynamics of Economic Growth and Political Instability in Dev Countries', *System Dynamics Review*, 2 (1), 20-35.

Larsen, E. R., Morecroft, J.D., Murphy, 1991, 'Helping Management Teams to Model', Proc 1991 System Dynamics Conference, Bangkok, Thailand 281-290.

Geraghty D.M. and J. Lyneis (1985) 'Feedback loops: the Effect of External Agents on Performance' in J. Plummer, E. Oatman, P. Gupta (eds) *Strategic Management and Plan Electric Utilities*, Prentice-Hall, NJ, USA

Morecroft, J.,D., J.D. Sterman, (1992), Modelling for Learning, Special issue of *The European of Operational Research*, 59, 1.

Morecroft, J.D., D. Lane, P. Vitai (1991) 'Modelling Growth Strategy in a Biotechnology Firm', *System Dynamics Review*, 7 (2), 93-116.

National Grid Company, 1992, 'Seven Year Statement', NGC, Kirby Corner Rd, Coventry C

UBS Phillips and Drew, 1990, 'The Electricity Industry in England and Wales', UBS Phil Drew, 100 Liverpool St, London EC2M 2RH.