The Design of Efficient Market Structures for Ancillary Services

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Abstract

The electricity industry has particular characteristics that create barriers to its successful commercialization. Electrical energy is instantaneously transmitted from generators to end-use equipment according to physical laws rather than commercial contracts. Any blueprint for commercialization must be compatible with these characteristics. The main commercial activities in a restructured electricity industry assume that electrical energy behaves as a commodity. Ancillary services play a crucial role in underwriting that assumption. Therefore, it is even more complex to achieve economically efficient outcomes in ancillary services than in the main commercial activities. This paper discusses approaches to this problem, with particular emphasis on recent proposals for changes to the implementation of ancillary services in Australia. It will be several years before the success of these proposals can be measured.

1. Introduction

The electricity industry has particular characteristics that create barriers to its successful commercialization:

- Electrical energy is instantaneously transmitted from generators to electricity consuming equipment and no third party, such as a retailer, has intermediate physical ownership of the product.
- Physical laws rather than commercial contracts determine the flow of electrical energy. Thus generators, network operators and consumers all share responsibility for whether electrical energy arrives at consumers’ equipment and, if it does, whether it is of “merchantable quality”.
- The lack of cost-effective storage of electrical energy implies that supply/demand balance can change instantaneously. Imbalance between supply & demand places security of supply in jeopardy and must be corrected promptly by technical means (ancillary services) rather than waiting for a market to clear.

Any blueprint for commercialization must be compatible with these characteristics. This paper discusses approaches to the design problem, with particular emphasis on the issue of ancillary services.

2. Models of the electricity industry

In developing a design for commercialization of the electricity industry, it is useful to keep four perspectives in mind:

- Physical (near term “reality”)
- Mathematical-engineering
- Economic
- Commercial

The physical perspective on the electricity industry is concerned with the actual behavior of the set of electrical equipment that comprises the electricity industry. This very large set of equipment includes all generator and consumer equipment, network equipment and all control systems. Under most circumstances, this equipment behaves as intended. However unexpected events such as equipment failures can cause unintended behavior to occur with little warning.

The mathematical-engineering perspective on the electricity industry is concerned with models of physical behavior that are both sufficiently accurate and sufficiently tractable to be useful for simulation and design purposes. Low-order approximate models must be used because of the complexity of the industry. Different approximate models are used depending on the phenomena that are to be simulated. These models are abstracted in important ways from the actual behavior that they represent. Also, engineering analysis assumes that no data provided by participants for use in these models will be deliberately misleading.

The economic perspective on the electricity industry is concerned with models of physical behavior that are both sufficiently accurate and sufficiently tractable to be useful for simulation and design purposes. Low-order approximate models must be used because of the complexity of the industry. Different approximate models are used depending on the phenomena that are to be simulated. These models are abstracted in important ways from the actual behavior that they represent. Also, engineering analysis assumes that no data provided by participants for use in these models will be deliberately misleading.

The commercial perspective on the electricity industry is concerned with nature of the commercial interactions between the industry participants and, in particular, the