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Impact of electricity deregulation in the state of California

Ghazal Razeghi*, Brendan Shaffer, Scott Samuelsen

Advanced Power and Energy Program (APEP), University of California, Irvine, CA 92697-3550, United States

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ABSTRACT

The electric industry started as a natural monopoly and was regulated to protect the customers from high prices. Electricity deregulation was expected to reduce prices by introducing competitive markets. Every country or state implementing deregulation has gone through a unique experience. In this paper, the impact of electricity deregulation in the state of California is addressed by first examining historical retail prices, and second by developing a model to estimate the grid marginal costs using historical data. Results show that, although some customers pay lower rates today, the average customer does not pay a lower rate due to deregulation. Moreover, the results of the modeling show that the wholesale prices realized were higher than the marginal cost associated with the grid. Impacts of improved grid management are discussed along with transmission investments, market operator start-up and operation costs, energy and environmental goals, advances in technology on electricity prices, and the impact of deregulation on these factors.

1. Introduction

The purpose of the current analysis is to examine the impacts of electricity deregulation or restructuring in the state of California 20 years after the 1996 Federal Energy Regulatory Commission (FERC) issued Order 888 better known as the "Open Access" rule. In the same year, the California Public Utilities Commission (CPUC) passed Assembly Bill 1890, known as the Electric Utility Industry Restructuring Act that provided legislative guidance for electricity restructuring in the state of California. Debate on whether or not deregulation has helped or hurt the electricity industry, electricity prices, and ultimately customers continues (Apt, 2005; Borenstein and Bushnell, 2015; Joskow, 2008; Klitgaard and Reddy, 2000; Slocum, 2007). However, very few (Blumsack et al., 2008; Jahangir, 2011; Joskow and Kahn, 2002; Kwoka, 2008) provide quantitative analysis for their position on the success of electricity deregulation. Even fewer studies investigate the impacts of electricity deregulation after the passage of sufficient time to reasonably assess the results while the majority of the studies has focused on analyzing the 2000–2001 energy crisis in California and market power exercised by some entities (Borenstein et al., 2000; Joskow and Kahn, 2002; Joskow, 2001).

In the wholesale market, the spot price or market clearing price (MCP) is the price of the most expensive generators that is serving the demand. In an economic dispatch strategy, this will be the last generators that gets cleared in the market. Another way to explain the MCP is that it is the price that all suppliers operate at or below this price, and all the market participants get paid the same MCP. The bids that participants place are not only the cost of generation, but also include market participation fees and costs, and other costs associated with selling electricity such as Firm (or Financial) Transmission Rights.

The retail price of electricity consists of several components including electricity generation (energy), transmission (including, e.g., Transmission Access Charge and California Independent System Operator (CAISO) Grid Management Cost), distribution, and other fees such as the Competition Transition Charge which is associated with the cost of electricity restructuring. Overall the price of electricity depends on a variety of factors including generation mix and fuel prices (Borenstein and Bushnell, 2015), status of the transmission and distribution systems and investments in these systems, transmission congestion, electricity demand (which is itself a function of season, weather, and economic indicators), various rate structures and/or market regulations (e.g., market competitiveness and market power), and energy and environmental regulations.

In this study, a model has been developed that uses historical data for the state of California to determine the expected grid marginal cost of electricity and assess how close the actual wholesale prices of electricity have been to the anticipated wholesale prices calculated based on the grid marginal costs. This price-cost gap can indicate how

Abbreviations: CAISO, California Independent System Operator; CEC, California Energy Commission; COG, Cost of Generation; CPUC, California Public Utilities Commission; EIA, Energy Information Administration; FERC, Federal Energy Regulatory Commission; ISO, Independent System Operator; MC, Marginal Cost; sCOG, Simple Cost of Generation; WECC, Western Electricity Coordinating Council

* Corresponding author.
E-mail address: gr@apep.uci.edu (G. Razeghi).

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competitive the market has been and if deregulation has helped reduce prices. Other factors affecting prices including energy and environmental policies, and transmission and distribution system upgrade investments are also discussed briefly in this paper.

2. Background

The first investor owned utility was established by Edison Illuminating Company in 1882 on Pearl Street in New York and served around 60 customers in lower Manhattan. The electricity industry started as a natural monopoly when it made economic sense for a single company to operate the generation, transmission, and distribution of electricity. As the number of customers grew, so did the size of power plants as economies of scale were achieved. Soon, companies realized the value of sharing reserves and three utilities began to share their generating units and profits. In 1927, the first power pool was established in PJM[1] which operated the units for these utilities. To protect the customers from extremely high and unreasonable prices, the Federal Power Commission (FPC) started regulating the electricity industry and, by the end of 1930s, almost all aspects of the industry were regulated and the industry evolved into a vertically integrated monopoly.

In 1978, the Public Utilities Regulatory Policies Act (PURPA) provided the first step towards a competitive market. As the support for open access to transmission grew in the mid 1990s, FERC, on April 24, 1996, issued the Open Access rule (order 888) which required all transmission line owners, to provide nondiscriminatory service to others seeking such services. Moreover, this order ensures that all potential suppliers of electricity, from small suppliers to big utilities, have equal access to the market and market tools in order to compete in a fair environment. Order 889 established Open Access Same-Time Information System (OASIS) for showing available transmission capacity and reserving capacity to all entities. The transmission system was no longer limited to those who owned transmission assets and became available to everyone to compete in the market. After the open access and OASIS orders, FERC approved PJM as the nation's first fully functioning Independent System Operator (ISO)[2] in 1997. In the areas where an ISO is established, the ISO coordinates, controls, and monitors the operation of the electrical power system, within a single U.S. State, or encompassing multiple states (such as PJM[3]).

In 1996, the CPUC passed legislation to provide guidelines for electricity restructuring and, after two years in April 1998, the electricity market started operation in the state of California. The market in California was originally designed to include an *unbundled* market where an independent entity, the system operator, was responsible for ensuring the reliability of the grid and another entity, the market operator, settled supply and demand bids (Chow et al., 2005). In the original design, the day-ahead market, the California Power Exchange (CalPX), was also a separate entity and independent from the ISO. This configuration, one of the more complicated market designs, was not based on a serious analysis or practical experience (Joskow, 2001).

During the California Energy Crisis in May 2000, the electricity wholesale prices increased 800% and one of the state's investor owned utilities went bankrupt and another came close to bankruptcy. In 2001, CalPX went out of business as a result of the crisis and the state was left without a day-ahead energy market from 2001 to 2009. During this period, the market participants (known as scheduling coordinators in CAISO) had to enter the day-ahead scheduling process with balanced schedules. In April 2009, the Market Redesign and Technology Upgrade (MRTU) was implemented in which a day-ahead energy market was added to the CAISO along with other changes to improve congestion management, and dispatch of resources (Isemonger, 2009).

As mentioned before, the majority of the research in this area has been focused on the energy crisis and the shortcomings of the system designed and events that led to the crisis (Joskow and Kahn, 2002; Joskow, 2001; Wolak, 2000). In this study, the impact of deregulation in the state of California is assessed across the decade following the energy crisis.

3. Methodology

In Section 4.1, historical data from the Energy Information Administration (EIA) and California Energy Commission (CEC) are used to compare retail prices before and after electricity deregulation in the state of California to determine whether a pattern can be observed in prices. Retail prices in regulated and deregulated states are also compared and analyzed in the same section to examine the difference between the trends of retail prices.

To further assess the impact of deregulation, grid marginal cost estimates based on historical data inputs were developed to compare with the actual historical spot market prices after deregulation. In a competitive market, the spot market price should approach the grid marginal cost. This was undertaken to investigate the manner by which spot market prices compared with marginal costs of the grid. An ideal approach is to have hourly production of individual generators across the state, some appropriately estimated financial information for each generator (e.g., interest rate, debt term, debt/equity ratio, lifetime, capital cost, etc.), and detailed information on all other costs and fess (e.g. transmission cost, market participation fees, etc.), estimate the actual cost of generation associated with each generating unit, and from that estimate the grid marginal cost at each hour. Unfortunately such detailed data only exist for 2000–2001 during the energy crisis. Instead, a methodology is developed, which uses available data associated with grid mix, contribution of various types of natural gas units, demand profile, and transmission and distribution costs, along with a set of reasonable assumptions and inputs from the literature.

This methodology for grid marginal cost estimation was developed based on the assumption that the spot market price would be driven by natural gas units. This assumption is based on two observations. First, historically, the primary source for electricity generation in the state of California has been natural gas. As a result, the electricity prices were expected to be sensitive to the price of natural gas as depicted in Fig. 1, which shows the electricity spot market price in California (starting in April 2008–2013) versus the natural gas prices from the same timeframe (Energy Information Administration, 2016). At first, it appears that the two are not correlated; however, after separating the data associated with 2000–2001 energy crisis, it is evident that a strong correaltion exists between the wholesale electricity prices and the natural gas prices. The correaltion coefficient matrix for these two datasets is $R = \begin{bmatrix} 1 & 0.8288 \\ 0.8288 & 1 \end{bmatrix}$. The justification for removing the data associated with the energy crisis is based on the unusually (i.e., not business as usual) high electricity prices during this timeframe that (1) resulted from a variety of reasons studied extensively by others, and (2) had little to do with natural gas prices and more with the lack of sufficient generation and exercise of market power by several entities (Borenstein et al., 2000; Joskow and Kahn, 2002).

Second, historical cost of generation and prices from non-natural gas fired generating units derived from various sources (Bolinger and Wiser, 2011; California Energy Commission, 2010; Chung et al., 2015; Feldman et al., 2015; GTM Research, 2016; U.S. Department of Energy, 2009; Wiser, 2013; Wiser and Bolinger, 2008; Wiser et al., 2012) were compared with the estimated cost of generation for natural gas units based on the methodology described in this paper, which confirmed that the natural gas units were the most expensive units in

[1] Pennsylvania-New Jersey-Maryland
[2] An ISO is an organization formed at the direction or recommendation of the FERC
[3] PJM coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia