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The response of large industrial energy consumers to four coincident peak (4CP) transmission charges in the Texas (ERCOT) market

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A B S T R A C T

Large industrial energy consumers served at transmission voltage in the ERCOT market reduce their consumption up to 4% during intervals in which consumers are charged for transmission services. The response normally lasts two to three hours, since consumers do not know exactly which interval will set one of the four summer coincident peaks (CPs), which are the basis for transmission charges. Thus, the design of transmission prices in ERCOT has been successful in eliciting demand response from that market's largest industrial energy consumers. However, there is no noticeable response during some CPs, reflecting the difficulties in predicting the actual timing of the peak. The response by industrials served at primary voltage to the price signals is insignificant.

1. Introduction

When the Electric Reliability Council of Texas (ERCOT) wholesale market was redesigned to foster competition among generators and provide a foundation for retail competition during the 1999–2001 timeframe, the Public Utility Commission of Texas (PUCT) grappled with how to charge consumers for transmission services under the new unbundled market structure. Under the resulting policy, large industrial energy consumers with interval data recorders (IDRs) are charged for transmission services based on the individual consumer's contribution to four coincident peaks (4CPs), i.e., the 15-min intervals of highest demand on the ERCOT system in each of four summer months – June, July, August, and September. The total level of compensation provided to transmission owners is approved by the PUCT each year. Transmission costs are then apportioned to each load, or user of the transmission system, based on its share of total demand during these 4CPs. The costs are recovered through levelized monthly charges paid the following year. Revenues from the transmission charges are collected by the retail electric provider (REP) providing electricity to the consumer at the retail level and these revenues are ultimately passed through to transmission owners.

A consumer that can reduce its demand for electricity by 1 MW during each of the four CPs can save about $25,000 in transmission charges the following year, as illustrated in Table 1 for energy consumers in the three largest transmission and distribution utility (TDU) services areas. This potential avoidance of transmission charges provides a strong incentive for industrial energy consumers with some flexibility in their operations to engage in "4CP chasing." In 2012, 14 REPs and eight municipal utilities or co-operatives, as well as a number of consulting firms, operated 4CP forecasting services to notify industrial energy consumers of opportunities to reduce their transmission costs by strategically reducing their energy purchases during the summer peaks (Wattles and Farley, 2012).

Despite the significant potential savings, not all industrial energy consumers respond to transmission prices. Some industrial facilities have little flexibility in their operations. A curtailment may impose economic costs upon some consumers in excess of the value of the potential savings in transmission costs. Energy consumers with the ability to easily interrupt or curtail their purchases from the grid and commit to providing an ancillary service to the ERCOT market (i.e., commit to curtail at the request of the system operator to provide an operating reserve) cannot concurrently chase 4CPs. This could limit the response of an interruptible load that had elected to provide an ancillary service in ERCOT's day-

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Table 1
Example savings calculations for a 1 MW reduction in demand during 4CP periods.

	Monthly charge per previous year's 4-CP kW	Annual savings from a 1 MW demand reduction during 4CP periods
CenterPoint energy		
Primary voltage (with IDR)	$2.1546	$25,855.20
Transmission voltage	$2.1187	$25,424.40
Oncor		
Primary voltage (with IDR)	$2.5684	$30,820.25
Transmission voltage	$2.6368	$31,641.71
AEP-Texas Central		
Primary voltage (with IDR)	$1.9250	$23,100.00
Transmission voltage	$1.7180	$20,616.00

Source of rates: http://www.puc.texas.gov/industry/electric/rates/Trans/TDGenericRateSummary.pdf, Last accessed December 15, 2012. The calculations assume the customer has a power factor of one.

ahead market or has an obligation with a load-serving entity through a bilateral arrangement to "be available" to provide a curtailment at ERCOT's request.

Demand response to the 4CPs may also be hampered by difficulties in predicting the CPs. Until a summer month is over, the interval with the highest level of system demand is not known. It is particularly difficult to discern whether a hot day during the first week of a month will indeed set a CP, since weather forecasts for the later days of the month will not yet be widely available, and any available forecasts so early in a month will possess considerable uncertainty. Further, a strong response to a likely CP may move the monthly peak demand to a different 15-min interval within the same day or to another day.

When the service areas of the investor-owned TDUs were opened to retail competition in January 2002, consumers with a non-coincident peak demand or "billing demand" of over 1 MW were required to have Interval Data Recorders (IDRs) installed. The interval-level measurements obtained from IDRs facilitates the settlement of energy generation transactions and provides a measurement of each large load's contribution to the 4CPs. The IDR threshold was lowered to 700 kW in 2006 (Raish and Turns, 2004).

Until recently, the contribution of smaller consumers (e.g., residential and commercial energy consumers) to the 4CPs was difficult to cost-effectively measure, so generic profiles were used to approximate their level of demand in given time periods. As a result, there is no direct benefit to an individual residential or small commercial consumer from reducing electricity use during a 4CP. Perhaps this situation will change, once advanced metering systems are fully deployed.

On occasion, the staff of ERCOT has provided graphs showing a significant drop in demand from large industrial energy consumers during a 4CP. In previous studies of the response of industrial energy consumers to price signals in the ERCOT market, real-time energy prices were combined with the 4CP transmission prices and consumer response to the combined prices was analyzed. It was apparent that certain customers responded to wholesale market price signals – either the 4CP charges, real-time energy prices, or both (Zarnikau and Hallett, 2008; Zarnikau et al., 2007). In this analysis, the focus is solely on the 4CP transmission charges.

In the U.S., demand response activities are increasing (FERC, 2012). The price elasticity of demand of industrial electricity consumers has been estimated in a number of previous studies, including Boisvert et al. (2007), Herriges et al. (1993), Schwarz et al. (2002), Taylor et al. (2005), and Choi et al. (2011). In these studies, the response to changes in wholesale generation prices or retail energy prices was the subject. The only previous analysis of customer response to CP transmission prices with which we are aware is Liu et al. (undated). That study simulated the benefits to data centers of avoiding transmission charges, rather than analyzing the actual consumption behavior of industrial facilities.

This paper contributes a more-detailed analysis of consumer response to 4CP in ERCOT than has been conducted to date. In Texas, a better understanding of demand response is critically important in light of ERCOT's "energy-only" market design which relies extensively on market forces to balance supply and demand. As low natural gas prices have impaired the profitability of constructing new power plants in recent years, means of reducing peak demand and preserving system reliability through demand response have become increasingly important. It is anticipated that this analysis will also prove instructive to those faced with the task of designing tariffs for transmission service for other markets or utility systems. An important consideration in the design of transmission prices is the impact such pricing will have on system demand. While the design of policies to foster the efficient operation of wholesale electricity markets tends to focus on electricity generation, transmission pricing can make an important contribution toward reliability and efficiency by affecting consumption behavior during peak periods, as is demonstrated in this analysis.

The following section uses a regression approach to explore the degree to which these two groups of large energy consumers respond to the transmission prices. Section 3 estimates the response of consumers served at transmission voltage to the 4CP-based transmission prices using a historical baseline approach. The final section summarizes our findings and offers some observations.

2. Do large consumers respond to transmission prices?

As noted above, large consumers of electricity in ERCOT with their interval-level consumption metered with IDRs can realize significant cost savings by reducing their purchases during the 4CPs. But, to what degree do they indeed take advantage of this opportunity and respond to this price signal?

To explore this question, 15-min interval aggregated load data for the two groups of energy consumers thought most likely to respond to 4CP events were obtained from the staff of ERCOT. These groups were 1) consumers with a non-coincident peak demand (billing demand) that exceeded 1 MW at least 10 times since January 2002 and were served at transmission voltage and 2) consumers served at primary voltage with a peak demand meeting these same criteria. The former group includes many very large refineries and chemical production facilities along the Gulf Coast. Data for the period from January 2007 through mid-2012 was used in this analysis.

Regression models were used to screen whether demand by the two groups of consumers during summer afternoons were affected by the transmission price signals. The observations used in the estimation were confined to the nine 15-min intervals from 3:00 p.m. through 5:15 p.m. (intervals 61 through 69) during weekday summer months. In recent years, the monthly CPs during the summer have always fallen within this period.

Because the timing of the CPs cannot be perfectly predicted (and a response by consumers to an anticipated CP period could shift CP to a different interval), we are interested in detecting both 1) any reduction in demand during an actual CP and 2) changes in consumption during other intervals when a CP might have been considered probable. To determine the intervals when consumers might have thought a CP was likely, a logistic regression model was used to estimate the historical relationship between a CP and a set of explanatory variables. Variables representing the month of the year and interval within the day were included to capture seasonal and diurnal factors affecting electricity use. The variable *Interval61_62_63* represents the period from 3 p.m. to 3:45 p.m., while