The Effects of Industrial Real-Time Pricing on Electric Utility Emissions

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## Overview

Economists have long advocated electricity prices based on marginal costs. In its current form, real-time prices (RTP) are hourly prices that correspond to the hourly cost of providing electricity. Recently, however, economists investigating the impact of actual and potential deregulation of electricity and the likely increase in the use of RTP in a deregulated environment have suggested the possibility that such rates could have negative effects on the environment. Holland and Mansur (2008) find that real-time rates could increase or decrease emissions, depending on base and peaker technology. However, HM do not examine real-time rates per se, but rather simulate any pricing mechanism that reduces the demand variance of electric system load.

In contrast to HM, our starting point is to evaluate emissions for customers billed on an RTP tariff (Duke Energy Company’s Schedule HP (hourly pricing)). System emissions for SO2, NOx, Hg, and CO2 under real-time pricing are compared to an estimate of system emissions if these customers were billed under a hypothetical flat rate that does not vary by time of use. Since we do not have flat rate data for our customer sample, we estimate how these customers would respond to the flat rate using demand response built upon a model of price response developed by Taylor, Schwarz, and Cochell (2005). We also estimate emissions had these customers stayed on Duke’s time-of-use (TOU) rate, which contains a peak, off-peak differential based on historical, but not real-time conditions.

## Methods

Step 1: Regress actual data on hourly load for customers on real-time rates using an extension of the Generalized McFadden model of our 2005 paper. Independent variables are prices and an output index. Previously we calculated intra-day own and cross elasticities. Extensions are to allow for responses to differ above and below a threshold price, and to calculate inter-day responses.

Step 2 – Calculate TOU rates for each customer by month.The marginal energy price for an on peak hour is On Peak Energy Price + the appropriate On Peak Demand Price / On Peak Load Factor / On Peak Hours.

Step 3 – Calculate the load determined by the TOU prices. This is accomplished by substituting the TOU prices calculated in Step 2 into the equation in step 1.

Step 4 – Adjust the load shape created in Step 3 so that the total energy under the shape matches the total energy under the actual load shape for these customers. This is the load that will be used to calculate the substitution effects. The income effects are the difference in the two load shapes

Step 5 – Using a dispatch model, calculate corresponding emissions for real-time and TOU prices.

Steps 6, 7, 8 and 9 correspond to steps 2, 3, 4 and 5 except they are applied to flat rate prices. These prices are calculated on a customer by customer and month by month basis. They are calculated by multiplying the real-time hourly price in each hour by the load in that hour, summing all these values and dividing by the total load.

## Results

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 3** |  | |  | |  |  | |  | |  |
| Comparison of Emissions under RTP, Flat Rates, and TOU | | | | | | |  |  |  |  |
| **Change in Emissions, RTP versus Flat Rate/TOU, tons\*** | | | | | |  |  |  |  |  |
| **Flat Rate** | | | | | | **TOU** | | | | |
|  | **SO2** | **NOx** | **Hg\*\*** | **CO2** | **Δ Energy** | **SO2** | **NOx** | **Hg\*\*** | **CO2** | **Δ Energy** |
| **2006** | -23.68 | -6.55 | -89.03 | -1492.34 | 0 | 36.64 | 1.27 | 104.91 | -5067.29 | 0 |
| **2007** | -11.83 | -4.85 | -3.22 | -1,081.77 | 0 | 19.38 | 3.45 | 19.67 | -1,978.80 | 0 |
| **2008** | -29.72 | -4.04 | -43.61 | 2,596.24 | 0 | 29.31 | -0.89 | 55.63 | -6,899.02 | 0 |
| **2009** | 1.59 | 1.09 | 57.56 | 2,346.17 | 0 | -28.31 | -7.87 | -443.13 | -18,478.94 | 0 |
| **2010** | -20.57 | 1.54 | 113.86 | 9,779.55 | 0 | -4.26 | 0.81 | 12.85 | 1,856.11 | 0 |
| \*negative number implies fewer emissions under RTP; \*\* in lbs. | | | | | | | |  |  |  |

## Conclusions

Real-time hourly prices shift use from peak to off-peak hours. Total emissions, which are the sum of peak and off-peak emissions, do not necessarily increase, contrary to Holland and Mansur’s findings. There is an increase in CO2 in the majority of years, particularly in the record hot summer of 2010. But SO2 emissions decrease in all but the unusually cool summer of 2009. If 2009 is viewed as an outlier because real-time prices were exceptionally low, NOx and Hg decrease in three of the remaining four years. Time-of-use rates result in much higher carbon emissions than RTP, except in 2010. However, sulphur emissions are lower in a majority of years. Finally, for Duke Energy industrial customers who opt for RTP, they would otherwise pay TOU rates, not flat rates. So for Duke Energy, customers who switch to RTP from TOU are likely to result in lower emissions of CO2, while other emissions increase in a majority of years.

## References

Holland, Stephen P. and Erin T Mansur. August 2008. “[Is Real-Time Pricing Green? The Environmental Impacts of Electricity Demand Variance](https://connect2.uncc.edu/ehost/,DanaInfo=web.ebscohost.com+viewarticle?data=dGJyMPPp44rp2%2fdV0%2bnjisfk5Ie46bNQsKi3T7ek63nn5Kx95uXxjL6nsEevpbBIrq%2beUbiptVKxp55Zy5zyit%2fk8Xnh6ueH7N%2fiVa%2bqs0q0qbZRsqmkhN%2fk5VXj5KR84LPjh%2bac8nnls79mpNfsVa6vt0yurLM%2b5OXwhd%2fqu37z4uqM4%2b7y&hid=12),” Review of Economics and Statistics, v. 90, iss. 3, pp. 550-61.

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