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MEMORANDUM

Date: June 14, 2004

From: Robert McCullough
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To: McCullough Research Clients

Subject: June 5, 2004 BES Incident

On Saturday night, June 5, 2004, at 23:15 prices reached $75,036.50/MWh. The value was clearly in error, but it was consistent with prices elsewhere in ERCOT:

Houston:	$75,036.50/MWh
North:	$40,348.46/MWh
Northeast:	$40,060.65/MWh
South:	$41.20/MWh
West:	$36,355.15/Mwh.

While ERCOT refuses to release definitive details about its pricing algorithms and procedures, the best of the incomplete information we have is found in a presentation by JunYu and Joel Mickey of ERCOT at a conference in Beijing China.[1]

On Saturday, April 19, 2004 the MCPE for interval ending 16:15 in Houston was $359.73/MWh,

[1]The presentation at the University of Beijing can be easily found by entering "ERCOT" and "Beijing" into Google.

greater than the largest price bid in the entire state for that hour, $300/MWh in SOUTH and HOUSTON. ERCOT has explained away the obvious discrepency between prices and bids by citing the complexity of its computational process.

In dramatic contrast, the June 5, 2004 MCPE for the Houston zone was initially set by ERCOT at such a high price that there is no question that it is in error. The June 5, 2004 value may be the highest price ever quoted for electric power anywhere.

ERCOT's reporting of bids above $300/MWh clearly establishes that no bids on the fifth were greater than $300/MWh.

On June 8, 2004 ERCOT released the usual Balancing Energy Services (BES) report for the period through June 6, 2004. The new report shows corrections to the initial reported MCPE values and shadow prices. In ERCOT's report of its corrections to the initial prices there is a field called "notes." ERCOT reports five corrections for the first six days of June, on June 1, 2, 3, 5 and 6, and the notes for every correction include the phrase "system error." Of the nine intervals with errors on these days, only two are accompanied by notes that say anything more than just "system error."

Any reasonable person dealing in this environment would very much want to know two things about these corrections. First, what was the precise computational process, the algorithm, including the data collection procedure, that was used to calculate the immense market clearing prices and huge corresponding shadow price for the SH path in the interval ending 23:15 on June 5, 2004.[2] And second, what was the precise computational process used to calculate the corrected values, published by ERCOT on June 8, 2004 - again, including information about data acquisition. When a price correction involves a change of nearly three orders of magnitude, with corresponding dollar implications on the order of about $20 million for events occurring in a fifteen minute time period; then simple common sense demands, at the very least, an open discussion of the details of the actions leading to these results. Yet ERCOT steadfastly refuses to explain what it does in a way that allows auditing.

How can we believe that ERCOT has never made a "system error" in calculating any of the prices for which corrections have not been issued? If other "system errors" have occurred, how can we know who has benefitted from those errors and who has been harmed and to what degree?

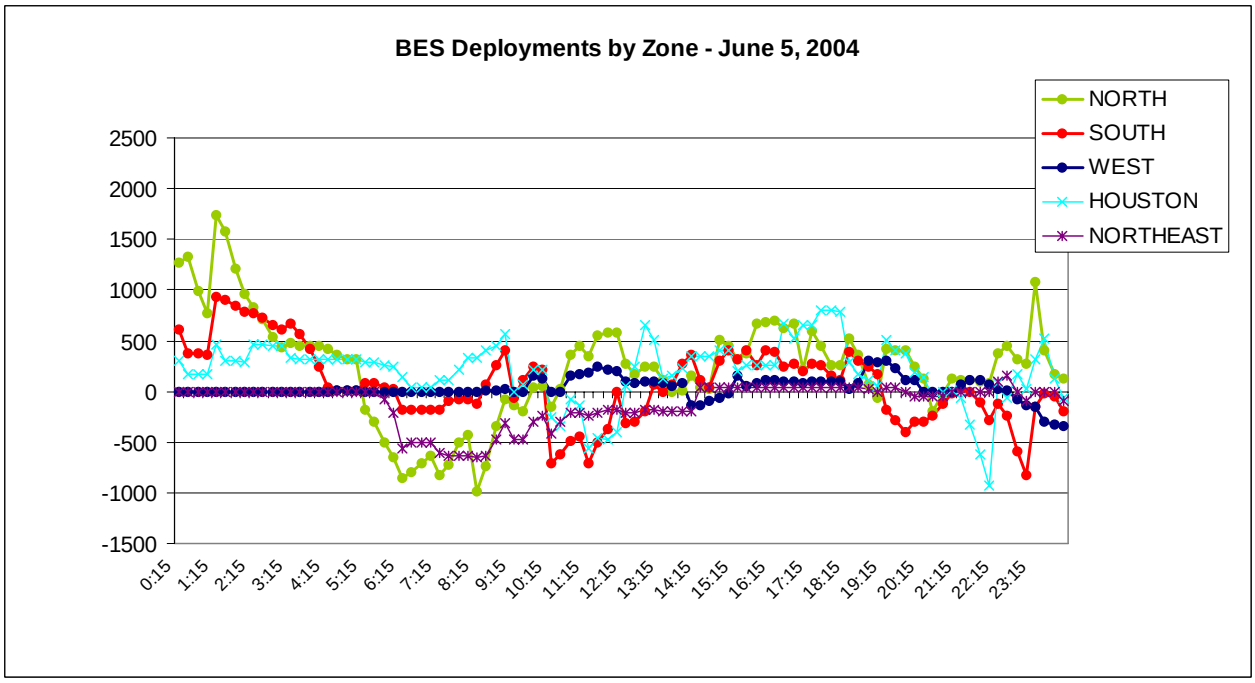
The shadow price for the one non-zero commercially significant constraint (CSC), South to Houston, was originally $205,861.38, a level hard to take seriously. The ERCOT correction puts the value at $233.91. This value is used to set charges for transmission between South Texas and the Houston area.

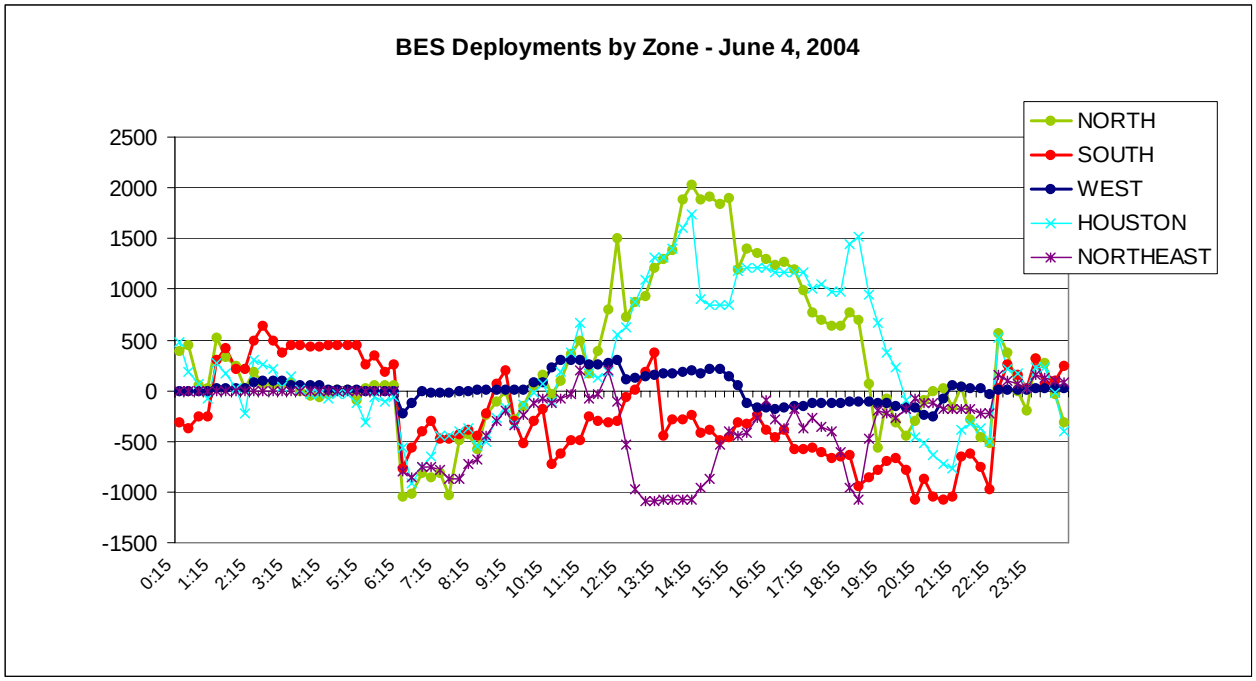
ERCOT's corrected BES report shows BES dispatch that implies, using ERCOT's published shift factors, a South-to-Houston flow of 882 MW that mildly violates the South-to-Houston CSC base operating constraint (OC0) limit of 818 MW, but not the relaxed operating constraint (OC1) limit of 1000 MW. A feasible BES dispatch exists that does not violate any OC0 path capability, unlike

[2]South to Houston transmission path.

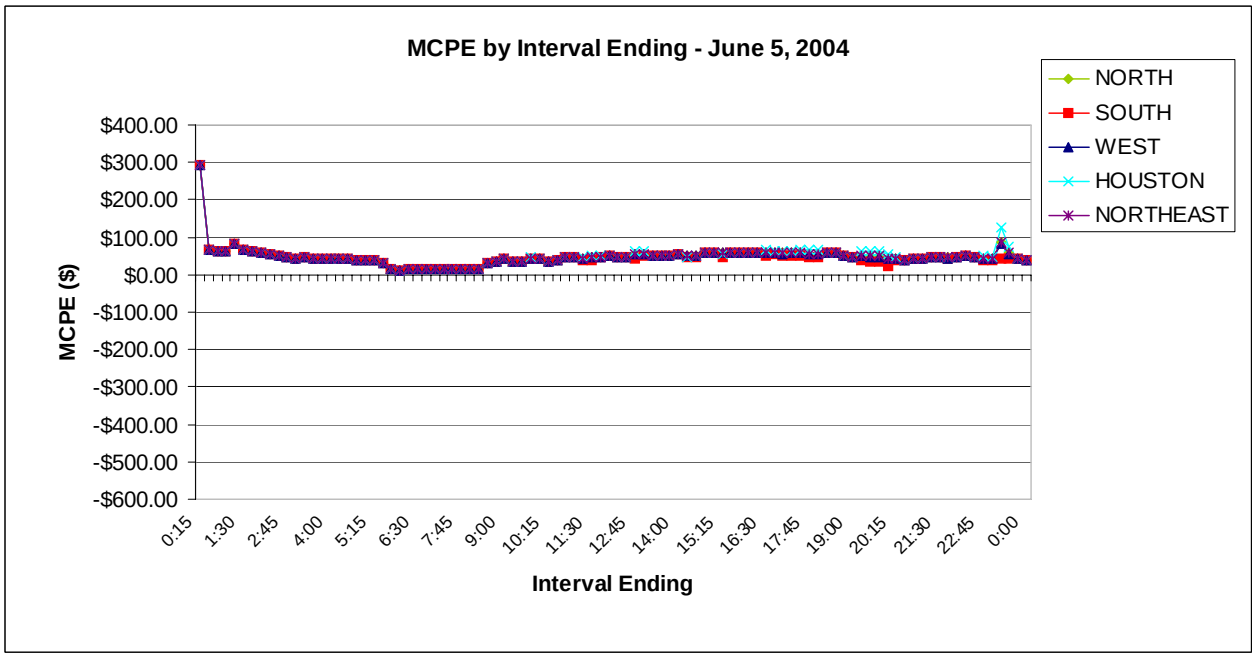
the apparent situation on April 19.

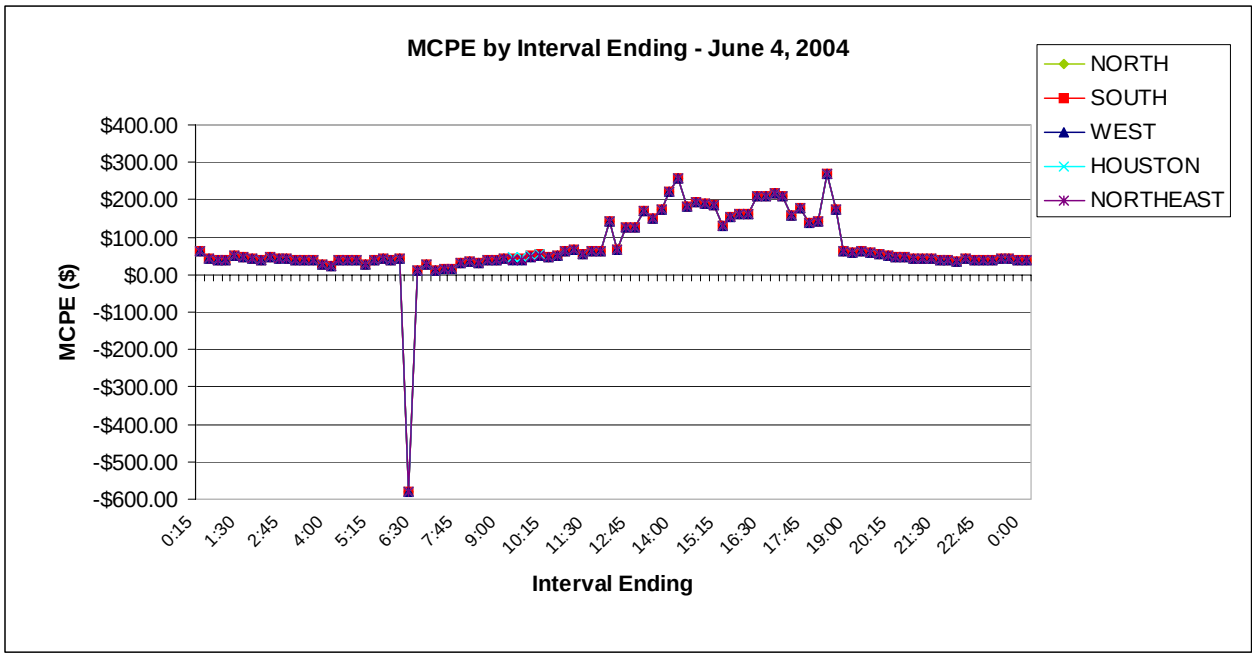
Perhaps the most frightening aspect of this pricing mistake is how easily it seems to have happened. Comparing Friday June 4, 2004 with Saturday, June 5, 2004, Saturday appears to be considerably calmer than Friday, as far as the need to use BES in the operation of the system, and generally in the progress of MCPE over the course of the day. The following two graphs show the course of BES deployment for these two consecutive days; not surprisingly, Saturday's deployment is considerably less variable than Friday's.





The anomaly occurred at a time not known for circumstances that challenge electric power systems, about 11 PM on a Saturday night. The MCPE values - after the Saturday corrections - for these two days show Saturday to generally be very unexciting, compared with Friday; as illustrated by the following two graphs:





Originally, the small peak in the price curve at the end of the day, June 5, was an incredible spike nearly a thousand times as large as the one in the above graph. Given the otherwise placid price landscape, the initial jump was extremely alarming. No errors were reported or corrected by ERCOT for Friday, June 4, 2004, but the large negative prices and down-deployment of balancing energy in the interval ending 6:15 pose a stark contrast to the rest of the fairly placid day.

Why is ERCOT's computational procedure so fragile?

A careful reading of the University of Beijing presentation and the limited information ERCOT has provided indicates that the linear programming algorithm may be prone to errors. In 2004, ERCOT went from four to five zones. The approach used by ERCOT effectively doubles the size of the mathematical problem for each additional zone.

We also know that ERCOT does not use the traditional Linear Programming algorithm invented by John Von Neuman and John Nash during the Second World War. Instead, they use a penalty function technique. The difference is straightforward. Traditional Linear Programming does not allow any violation of operating constraints. The penalty function does allow constraints to be violated, but charges an enormous penalty for the violation.[3]

At $75,036.50/MWh, it is likely that the algorithm is simply running out of time. When this happens, the constraints are still unfulfilled and the algorithm reports the actual cost plus the enormous penalty.

When the algorithm fails, ERCOT has adopted a "duct tape" procedure known as Market Bulletin Number 5. This bulletin recommends approximations if the algorithm's results to not seem reasonable.

The June 5, 2004 incident indicates that Market Bulletin Number 5 may not be sufficient to fix the algorithm.

Why should market participants care?

The high price on the fifth was a clear signal to ERCOT staff that the results were in error. The April 19, 2004 incident was not so clear, and ERCOT has let the prices stand. As things now stand, it is very difficult to know which of ERCOT's prices are correct and which are incorrect.

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[3]For example, if a transmission line can only carry 1000 megawatts, traditional Linear Programming will guarantee that the flows along the line are always less than the limit. The penalty function allows the line to be overscheduled, but charges a large value to encourage the algorithm to fix the overscheduling in the next iteration.