BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems	Rulemaking 10-12-007 (Filed December 16, 2010)

REPLY COMMENTS OF MARK B. LIVELY, UTILITY ECONOMIC ENGINEERS, ON THE NEED TO CREATE A PROGRAM TO PRICE IMBALANCES

During the early 1970's I worked in the Controller's Office and then the Rate Department of American Electric Power Service Corporation in New York City. Years later a friend in California who had also worked at AEP told me that AEP's chief engineer had claimed that AEP could build a super-conducting transmission line but that the accountants wouldn't let him. My response was that the accountants wouldn't let him because the state regulators wouldn't allow them to socialize the cost by increasing all retail rates by a large percentage.[1]

The relevance of this story about super-conducting transmission systems is not whether Energy Storage Systems can be built, or even if the claim was truly made. Rather the relevance relates to who is going to pay for Energy Storage Systems. Is California going to socialize the cost of Energy Storage Systems and force all consumers[2] to bear a share of the cost whether they contribute to the need or not? Or does California wish to adopt a causative concept by

[1] FERC's recent tendency to socialize the cost of merchant transmission lines causes my response to be more moderate than it might otherwise be.

[2] See "Robin Hood vs Renewable Portfolio Standards: Do Renewable Portfolio Standards Reverse the Robin Hood Concept by Taking from the Poor and Giving to the Rich?" http://www.livelyutility.com/blog/

developing a competitive market for imbalances, such that the cost of Energy Storage Systems is borne by those parties who impose the need for Energy Storage Systems? Such a competitive market for imbalances is described later in these comments.

Socializing the cost of Energy Storage Systems may be tantamount to giving developers an open check book. In contrast, a competitive market for imbalances can lead to competition among developers of Energy Storage Systems, developers of other variable output resources, and developers of demand side management systems. Installing a competitive market for imbalances early in the process of the development of Energy Storage Systems will encourage right sizing of the amount of Energy Storage Systems as well as right sizing of other variable output resources, and protect California consumers from excessive prices.

Pricing imbalances allows participants, other than just Energy Storage Systems, to act like Energy Storage Systems. Customers would be able control their loads contra-cyclically, taking more energy when the price is high and less energy when the price is low. Similarly, generators with some flexibility would be able to respond to shortages and surpluses on the system based on the value set for those system wide shortages and surpluses.

With a competitive market for imbalances, too many Energy Storage Systems would depress the price for storage, while increasing the value of other variable output resources like wind generation. In the opposite situation, too much wind generation would increase the value of Energy Storage Systems. A competitive market for imbalances will lead to a good balance between the amount of Energy Storage Systems in California and the amount of other variable output resources like wind generation. This right sizing of the market for Energy Storage Systems depends greatly on how the competitive market for imbalances will respond to the size of the imbalance. Sometimes that price response will mean negative prices.

DON'T PENALIZE IMBALANCES, PRICE THEM

Imbalances can wreck havoc with the electric system, whether the imbalance is the result of too much generation and too little generation. The FERC policy seems to be to penalize imbalances, as was demonstrated by its fawning admiration for the penalty approach of Bonneville Power Administration (BPA) in *Preventing Undue Discrimination and Preference in Transmission Services*, FERC Docket No. RM05-25-000 and RM05-17-000.

BPA allowed generators a small imbalance relative to scheduled generation but then penalized the generator for any additional imbalance, whether the imbalance was positive as the result of too much generation or negative, the result of too little generation. Applying the same approach to Energy Storage Systems would cause them to incur penalties for over-performing relative to dispatch signals, either by absorbing more electricity than had been scheduled or for generating more electricity than had been scheduled. A better approach is to change the imbalance system to a pricing mechanism, a pricing mechanism that can punish bad imbalances while rewarding good imbalances.

Since system imbalances wreak havoc on the system, the concurrent system imbalance should be an indication of whether a generator (or load) imbalance is good or bad. A generator imbalance that is adding to the system imbalance can be considered to be bad. A generator imbalance that is counteracting the system imbalance can be considered to be good. When there is no system imbalance, any generator imbalance can be considered to be neutral, neither good or bad.

The BPA imbalance mechanism is simple. It assumes all imbalances, after a minor dead zone allowance, is bad. If a generator produces more electricity than has been scheduled, the surplus is priced at 75% of the nominal price. This is in effect a 25% penalty. If the generator produces less electricity than has been scheduled, the shortage is priced at 125% of the nominal price. Again, this is effective a 25% penalty.

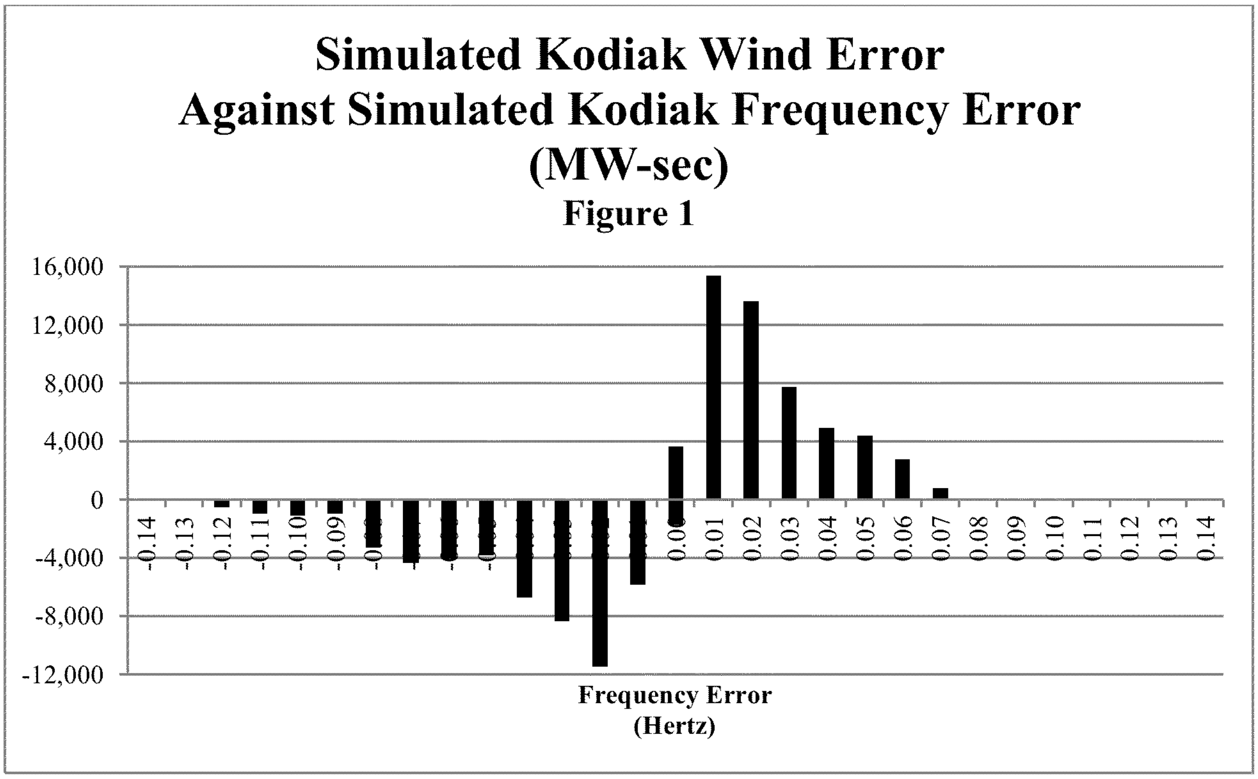
An alternative approach is to look at the system imbalance and the generator imbalance at the same time. When the system, **not the generator**, has too much electricity, then all imbalances would be priced at 75% of the nominal price. When the system, **not the generator**, has too little electricity, then all imbalances would be priced at 125% of the nominal price. This system imbalance approach to setting the multiplier for generator imbalances creates a competitive market as opposed to the penalty nature of the BPA approach. Both the BPA approach and the alternative competitive market approach can result in punitive charges to a generator for imbalances, but the alternative competitive market approach doesn't always produce a punitive effect and thus is not a penalty system.

Recently I received 2 second ACE and frequency data for Anchorage, Alaska, and 1 second wind farm generation data for Kodiak, Alaska.[3] I used the Kodiak data to create Figure 1.[4] The horizontal axis is the wind farm's simulated contribution to system frequency

[3] The two utilities are over 300 miles apart and are not interconnected electrically. However, the two utilities provided short interval data that could be used to illustrate the issues addressed in these comments.

[4] The figures and tables in these comments are taken from "Creating a Market for Wind Variances Instead of Imbalance Penalties," an upcoming paper that is being submitted for the Spring issue of *USAEE Dialogue*. I have scaled up the Kodiak wind data by a factor of 4.0 to approximate a wind farm that is planned for indirect connection to the Anchorage system.

error,[5] with a granularity of 0.01 Hertz. The height of each bar on the graph is the sum of the energy imbalances that occurred during the indicated simulated contribution to system frequency error during a one day period, 2010 October 1.



Positive and negative energy imbalances were summed separately. I note that the only instance of positive and negative energy imbalance for a particular system frequency error occurs when the system frequency error is zero. The granularity of Figure 1 means that a frequency error of zero covers frequency errors from -0.005 Hertz to +0.005 Hertz. The referenced negative energy imbalances occur while the frequency error is between -0.005 Hertz and zero. The referenced positive energy imbalances occur while the frequency error is between zero and

[5] I modeled the hourly wind schedule as being the exact average of the wind generation during each hour. For each 2 second interval, I calculated the wind imbalance as the difference between the average generation for those two seconds minus the hourly wind schedule. I converted the wind imbalance into its contribution to frequency error using a bias factor of 100 MW/Hertz.

+0.005 Hertz. **Absent the anomaly of a frequency range straddling zero, all of the positive energy imbalances would be on the right side of Figure 1 and all of the negative energy imbalances would be on the left side of Figure 1.**

The BPA imbalance pricing mechanism prices all energy imbalances on the right of Figure 1 at 75% of the nominal price. Since all of the energy imbalances on the right of Figure 1 are positive, the BPA imbalance pricing mechanism penalizes positive energy im balances 25% of the nominal price. The BPA imbalance pricing mechanism prices all energy imbalances on the left of Figure 1 at 125% of the nominal price. Since all of the energy imbalances on the left of Figure 1 are negative, the BPA imbalance pricing m echanism penalizes negative energy imbalances 25% of the nominal price. For purposes of discussion, the bar in the center of Figure 1 will be treated as a dead zone, priced at 100% of the nominal price.

Penalizing Figure 1 Imbalances
(MW-Seconds)
Table 1

Left	-51,574.42	125%	-64,468.02
Center	-1,721.79	100%	-1,721.79
	3,622.48	100%	3,622.48
Right	49,673.73	75%	37,255.30
Totals	0.00		-25,312.04

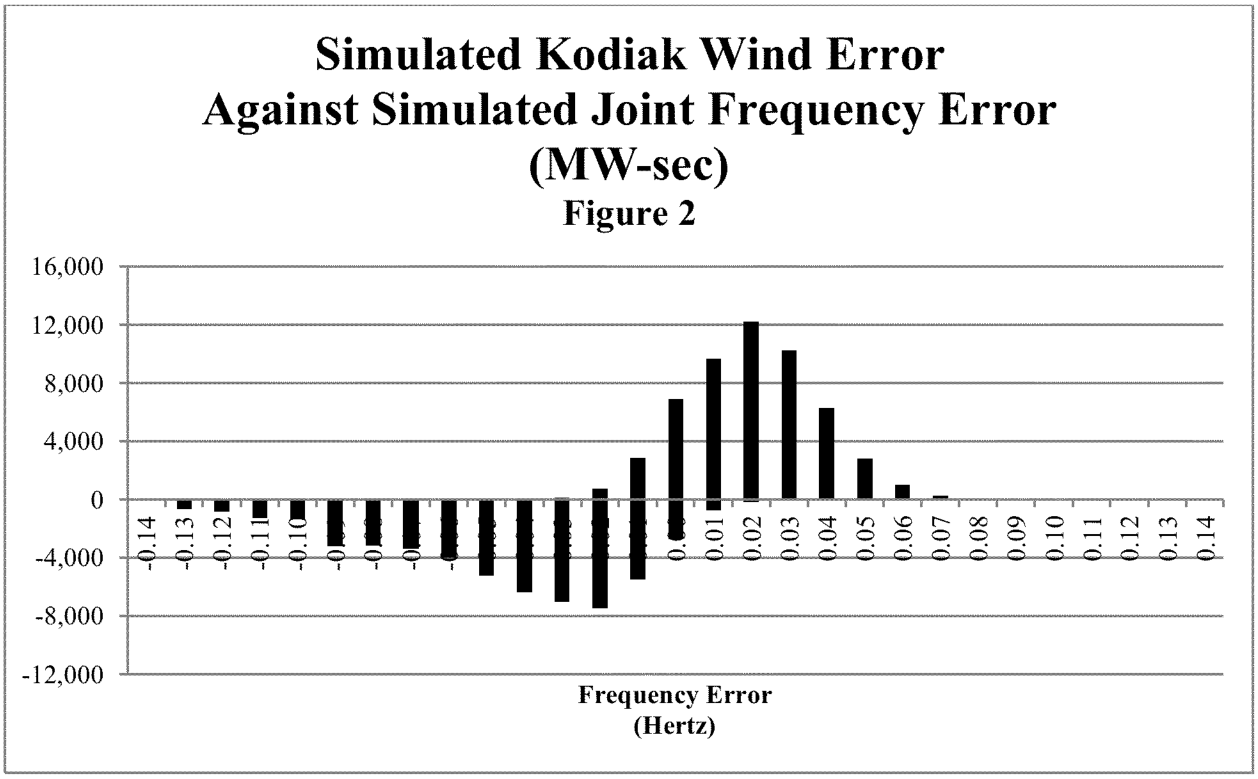
Table 1 applies the above penalty concepts to the energy imbalance numbers that produce Figure 1.

- The first row of Table 1 is for the left side of Figure 1, showing that the negative energy imbalances totaled 51,574.42 MW -seconds. The 125% multiplier results in a negative billing energy imbalance of 64,468.02 MW-seconds.

- The second row of Table 1 presents the corresponding information for the negative portion of the center bar at 0 Hertz. The 100% multiplier is reflective of a dead zone, where there is no penalty.
- The third row of Table 1 presents the corresponding information for the positive portion of the center bar at 0 Hertz, again with a 100% multiplier for the dead zone.
- The fourth row of Table 1 presents the corresponding information for the right side of Figure 1, showing that the positive energy imbalances totaled 49,673.73 MW-seconds. The 75% multiplier results in a billing energy imbalance of 37,255.30 MW-seconds.
- The fifth row of Table shows that the total imbalance billing energy is a negative 25,312.04 MW-seconds, while the actual net imbalance for the entire day is 0.00 MW-seconds.

The total positive imbalance energy is 53,296.21 MW-seconds, as is the total negative imbalance energy. As calculated in Table 1, there is a punitive effect of the generator having to pay a penalty for 25,312.04 MW-seconds of energy imbalance at the nominal price of energy, even though on a daily basis and on an hourly basis the wind system was perfectly in balance. All of the imbalance energy, whether positive or negative, pays a 25% penalty except for the imbalance energy in the dead zone around 0.00 Hertz.

Figure 2 presents an alternative way to organize the imbalances. The horizontal axis is now the simulated joint frequency error, the frequency error experienced by Anchorage on 2011 October 23/24 as adjusted by the wind farm's simulated contribution to system frequency error. The change in the horizontal axis results in a greater dispersion of the simulated energy imbalance across the horizontal axis. Some of the negative energy imbalance now appears on the right side of Figure 2 and some of the positive energy imbalance appears on the left side of Figure 2.



Pricing Figure 2 Imbalances
(MW-Seconds)
Table 2

Left	-49,633.08	125%	-62,041.35
	3,755.63	125%	4,694.53
Center	-2,741.13	100%	-2,741.13
	6,914.45	100%	6,914.45
Right	-921.99	75%	-691.49
	42,626.12	75%	31,969.59
Total	0.00		-21,895.40

The financial impact of the change in definition of the horizontal axis is presented in Table 2. The left side of Figure 2 has 3,755.63 MW -seconds of positive imbalance, compared to the absence of any positive imbalance for the left side of Figure 1. This positive imbalance has a multiplier of 125%, whic h provides a bonus to the wind farm of 25%, as shown in the second line of Table 2 . The right side of Figure 2 has 921.99 MW -seconds of negative imbalance, compared to the absence of any negative imbalance for the right side of Figure 1. This negative imbalance has a multiplier of 75%, which represents a bonus of 25% to the wind farm.

Under the penalty mechanism shown in Figure 1 and evaluated in Table 1, an Energy Storage System would have to make deals with wind farms to explicitly offset their imbalanc es. Under the pricing mechanism shown in Figure 2 and evaluated in Table 2, an Energy Storage System could be connected to the system and operate in a counter cyclical manner . A further advantage of the pricing mechanism is that Energy Storage Systems wo uld be able to optimize against all opportunities on the grid, not just against the operation of single wind system.

The market price should respond to the size of the imbalance. The BPA penalty plan in Figure 1 and Table 1 has 25% penalties. A competitive price for imbalances, as shown in Figure 2 and Table 2 , converted the 25% penalties into 25% price adjustments. However, the price adjustments should vary with the size of the shortage . A 0.02 Hertz variance should cause a greater adjustment than would a 0.01 Hertz variance . A 0.03 Hertz variance should cause an even greater adjustment.

Sometimes the penalty/bonus should be greater than 100% . The result in the context of Tables 1 and 2 would be a multiplier that is less than zero or greater than 200%. In regard to a multiplier less than zero, o ther markets have shown that the appropriate economic signal for electricity can be a negative price . This was shown in ERCOT, both in regard to large wind surpluses and in regard to large generators with great inertia. The negative prices in the highly windy area of West Texas led to negative prices in heavily industrialized Houston.[6]

The discounts associated with unscheduled energy from wind farms increases with the size of the wind farm. [7] As the amount of wind farm activity increases in California, this diseconomy of scale phenomenon will increase the price that would be seen by Energy Storage Systems, increasing their economic viability. Having in place a plan for paying for unscheduled imbalances could increase the speed with which Energy Storage Systems are installed.

ABOUT THE AUTHOR OF THESE COMMENTS

I am a Professional Engineer registered in the District of Columbia. I have a BS in Electrical Engineering from the Massachusetts Institute of Technology and an MS in Management from the Sloan School of Management of the Massachusetts Institute of Technology. I began my utility career with five years employed by Kentucky Power Company and American Electric Power Service Corporation, both being branches of American Electric Power (AEP.) I spent fifteen years with the Washington Utility Group of Ernst & Ernst and its successors, Ernst & Whinney and Ernst & Young. I have been self employed for twenty years. My resume and many of my published articles are on my web site, www.LivelyUtility.com. In this proceeding I am representing myself.

[6] "Renewable Electric Power—Too Much of a Good Thing: Looking At ERCOT," *Dialogue*, United States Association for Energy Economics, 2009 August.

[7] An example of this phenomenon will be shown in "Creating a Market for Wind Variances Instead of Imbalance Penalties."

Pursuant to Section 5.2 of the Order Instituting Rulemaking, I understand that I "become a party [to this proceeding] after the first 30 days, . . . by filing and serving timely comments in the Rulemaking (Rule 1.4(a)(2))." I provide the following information pursuant to Section 5.1 of the Order Instituting Rulemaking:

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I will serve these comments on the parties with e-mail addresses on the official service list and will provide a signed paper copy of these comments to the assigned Commissioner and Administrative Law Judge.

Respectfully submitted,

/S/

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