REPORT TO THE LEGISLATURE
ON WIND CURTAILMENT PAYMENTS
UNDER MINNESOTA STATUTES §216B.1681

Submitted by the

Minnesota Public Utilities Commission

July 2008

INTRODUCTION

The Statutory Requirement:

Minnesota Laws, 2007, Chapter 136, provides the following:

> Sec. 9. **[216B.1681] CURTAILMENT PAYMENTS.**
> The commission shall conduct a study of curtailment payments for wind energy projects to assess whether utilities are unduly discriminating among project ownership structures in regard to the contractual availability of curtailment payments. The commission shall submit the study to the chairs and ranking minority members of the senate and house of representatives committees with primary jurisdiction over energy policy by January 15, 2008.

Though belated, this report is intended to fulfill the requirement of this section.

Report Scope:

In this report, the specific analysis of possible discrimination is limited to wind energy projects subject to curtailment in purchase power agreements (PPAs) with Northern State Power Company d/b/a Xcel Energy (Xcel). Historically, Xcel has by far the largest number of individual wind projects under contract in Minnesota. We are not aware of any significant curtailment payment issues for other electric utilities at this time.

The Commission examines curtailment provisions, along with all other provisions, of PPAs that are before it for approval. The Commission has required Xcel, as well as other rate-regulated electric utilities, to report on actual curtailment and any associated payments as part of their monthly fuel adjustment charge report.

BACKGROUND ABOUT WIND CURTAILMENT

What is curtailment, why is it necessary and when?

"Curtailment" in the context of Minnesota's electric industry occurs when a deliberate action is taken to reduce a portion or all of the energy capable of being produced from a generating facility. Such action may be needed if the amount of generation energizing the electric grid within a particular control area exceeds either available transmission capacity or the demands of the load taking the energy off the grid, or a combination of these factors. Transmission constraints can occur anytime, but are more pronounced during system peaks. Low-load conditions typically occur during nights, weekends or holidays. Adjusting generation under low-load is more effectively accomplished with generators that are more flexible to cycle than base-load plants. Under these variable circumstances, curtailment of

generation is a way to ensure supply and load stay in balance and potential problems with reliability, stability and even safety are avoided. Utilities have an obligation to follow the Midwest ISO's operating requirements to take actions to assure this critical balance.

Why wind?

Curtailment has been found necessary in conjunction with Minnesota's wind generation resources mainly because of transmission constraints and policy goals for wind development. The geographic areas most suited to wind development in Minnesota are removed from significant load centers and the transmission infrastructure in the wind resource areas of the state is not always sufficient to deliver to load the amount of wind energy produced at any one time. Also, construction of wind generation, which can be done relatively quickly compared to other forms of generation, has outpaced transmission capacity in many areas of Minnesota. This somewhat faster pace of wind generation development has also been affected by the availability of federal Production Tax Credits (PTCs), which help to keep wind generation competitive with other fuels. Because of uncertainty about the continued availability of these credits, waiting for completion of necessary transmission upgrades would have risked higher prices for ratepayers.[1] Consequently, wind contracts were signed to lock in tax credits even though transmission facilities were not always available.

Therefore, compensation for curtailed wind generation has been deemed necessary to allow wind generation development to continue to occur while transmission infrastructure issues are being addressed.

Why payments?

If curtailment is deemed necessary when wind generators are operating, the revenue stream for those generators is interrupted. In this instance, curtailment payments help make winder developers "whole" for the lost revenue and provide tangible certainty for investors, thereby bolstering renewable resource development in Minnesota while transmission infrastructure issues are addressed.

How are wind curtailment payments structured?

Curtailment payments for wind generation are structured on the basis of a price *per kilowatt-hour*; i.e., it is based solely on energy production ("energy-only") with no separate payment for capacity. Separate compensation for capacity is feasible when a generator can assure delivery of a specified amount of production within a specified (usually rather short) period of time. Because of the intermittency of wind, such a contractual obligation would be difficult (if not, impossible at this time) for wind generation to fulfill. Other forms of generation have the ability to offer capacity and, thus, can be compensated for it. A capacity payment allows them to cover the fixed costs incurred to provide the assured production

[1] PTC renewal has been extended numerous times, in each case for a limited period.

on short notice. Without capacity payments, wind curtailment payments must be designed to cover fixed *and* variable costs through the energy-only payment.

How are curtailment payments allocated?

To provide for effective grid operations as well as encourage renewable resource development, Xcel developed a curtailment protocol by which wind projects in Minnesota voluntarily agree to rotate the order of responsibility for reducing or turning off their generation if necessary.[2] Naturally, when curtailment is needed, the ability to access larger blocks of generation near the constrained area and quickly reduce generation as needed is important. Since each wind facility is controlled by the individual vendors (not the utility), Xcel would need to either contact each individual vendor or trip the breaker to accomplish the curtailment. Xcel opted to contact vendors directly, and, to avoid having to place numerous calls to individual 2 MW projects, it initially focused on the larger projects to get the rapid response needed. However, smaller projects that are effectively aggregated, like groups of projects operated by Northern Alternative Energy (NAE) and Norgaard, can also contribute and have been included in the protocol.

There are six projects participating in this rotation arrangement at this point. These projects are:

- Lake Benton Power Partners I (107.25 MW)[3]
- Lake Benton Power Partners II (103 MW)
- Chanarambie Power Partners (85.5 MW)
- Moraine Wind (51 MW)
- Northern Alternative Energy (various < 2 MW facilities ; total of 27 MW)
- Norgaard (several 1.25 MW facilities; total of 8.75 MW) – was included in the rotation in 2007[4]

Xcel's rotational system for allocating curtailment, and therefore curtailment payments, does not guarantee that curtailment will always occur strictly on the basis of relative cost. This is due to the fact that the PPAs for the various participating vendors establish negotiated energy prices which vary. Nevertheless, the rotational system avoids placing the burden of operational costs, lost tax credits and warranty issues, on one vendor, thereby not disproportionately disadvantaging that project. Moreover, because the curtailments are reliability-driven, the overall ratepayer obligation would not materially change over other forms of reliability-driven dispatch.

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[2] The Public Utilities Commission has taken no formal action regarding Xcel's rotation policy. However, Xcel's implementation and use of curtailment and treatment of associated payments is addressed by the Commission order in Docket Number E,G999/AA-04-1279.

[3] Nameplate capacity.

[4] When the MinnDakota (aka, Ivanhoe – 150 MW) and the Fenton Power Partners I (200 MW) projects become operational, they will ostensibly be added to the curtailment rotation.

Curtailment of facilities owned by Xcel has not yet occurred because the first large company-owned facility (The Grand Meadow Wind Project) will not be completed until the end of 2008.

Trend in Curtailment Activity

Xcel's total wind production in Minnesota has increased steadily during the period the curtailment program is been in effect. See Figure 1.

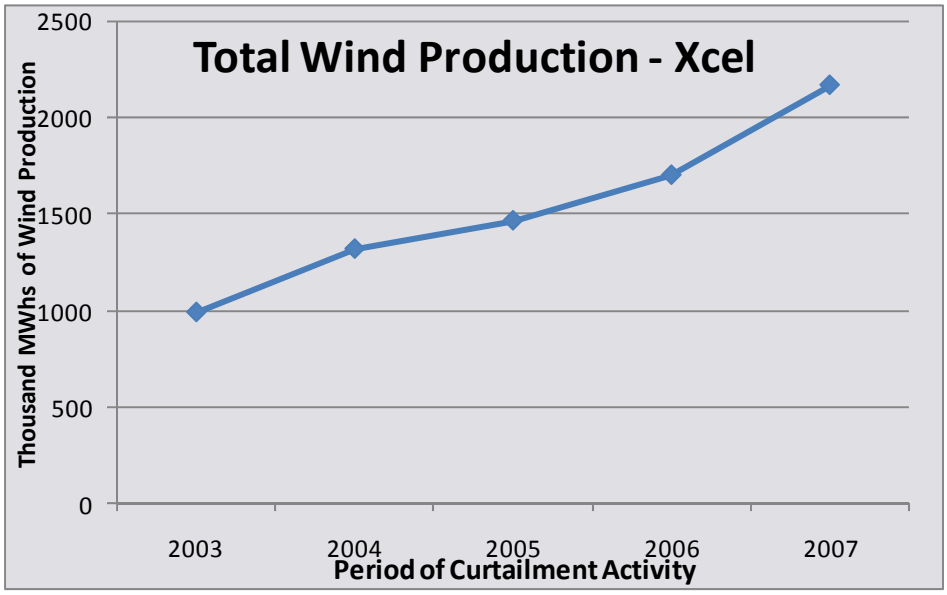

Figure 1

Curtailed wind generation has consistently been a small percentage of total wind production. However, as a percentage of total wind production, curtailed wind generation had fluctuated somewhat since the protocol was first used in 2003. Figure 2 (below) shows that curtailment as a percent of total wind generation was slightly over 2% in 2003, jumped to just over 14% in 2004 and has consistently been below 5% since 2004. The 2004 increase may be explained by the fact that several components of the southwestern Minnesota transmission project, the need for which was prompted by wind development in that part of the state, were not completed until the end of 2004. Once those facilities were in place, the percentage of total wind generation curtailed dropped during 2005 and 2006.

Figure 2 also shows that in 2007 there was a slight increase in curtailment as a percent of total wind generation even though total wind generation continued to grow. Xcel has noted that in 2007 there were significant planned transmission outages which were taken to allow continued construction of the Southwestern Minnesota wind transmission facilities. According to Xcel, to install and interconnect new transmission facilities, existing facilities must be taken out of service so the existing facilities are not electrified. In addition, Xcel stated that as of December 21, 2007, when it completed the major components of the Southwestern Minnesota transmission upgrade project, curtailment activity should

be expected to diminish and remain at relatively low levels. Of course, it is possible that addition of significant amounts of generation in that same area could eventually lead to constraints in the future.

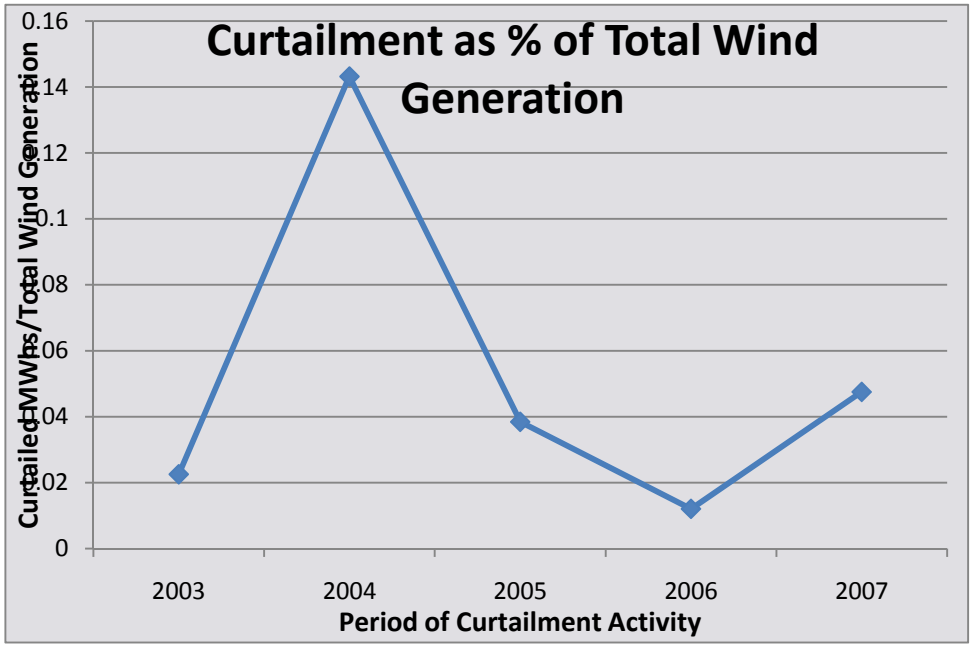

Figure 2

ANALYSIS REGARDING EXISTENCE OF DISCRIMINATION:

Curtailment Among Participating Wind Projects

How this curtailment activity was allocated among participating projects may help clarify whether discrimination has occurred. A disproportionate allocation of curtailment among participants would suggest discrimination may be occurring. To provide a measure of how curtailment (i.e., stated in terms of curtailed, or lost, MWhs) has been allocated, a Herfindahl (*H*) index has been employed. An *H* index is typically used to measure the extent of concentration of market share for firms in industries of interest.[5] An industry occupied by only one firm (i.e., 100% of the market share) would have an *H* index of 1.0, which is the highest value an H index can have. An increase in the number of firms sharing the market will cause the *H* value to decrease and be less than 1.0 (e.g., *H* = 0.500 if two firms shared equally), whereas inequality of share among participating firms will put upward pressure on the *H* index (e.g., *H* = 0.626 if the two firms had 75% and 25% shares, respectively)

[5] In that context, the Herfindahl index is the sum of the squares of each firm's market share [i.e., $H = \sum S_i^2$, or $H = \sum$ ((Firm A's market share)^2 + (Firm B's market share)^2 + . . . (Firm *n*'s market share)^2)]

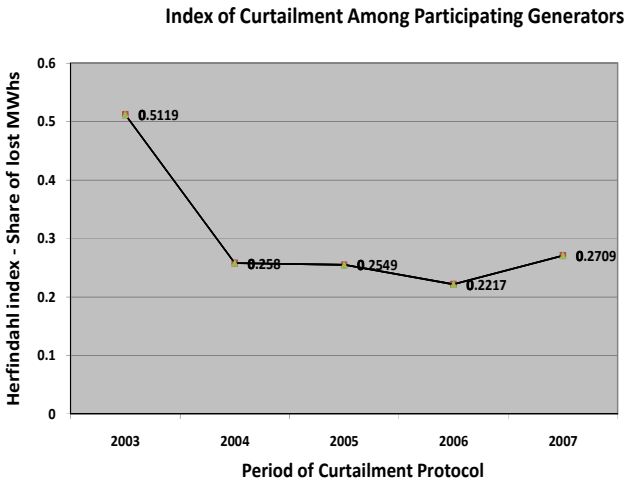

Figure 3

Figure 3 provides Herfindahl indices showing how curtailment has been allocated among participating projects (i.e., their "share" of curtailments) during the period 2003 through 2007. A perfectly even allocation of MWh curtailment among the six projects (i.e., each firm being curtailed exactly the same number of hours) would have produced an *H* index of 0.1667 for the five year period. As already noted, if one of the projects had been curtailed to the exclusion of the other projects, the *H* would have been 1.0. As can be seen in Figure 3, the allocation of curtailed hours in 2003 was more disproportionate than in subsequent years. This may have been due to the fact that the program was just beginning, there were only three projects participating at that time, and the most established generator (Lake Benton I) was relied on for most of the curtailment. However, since that time, the *H* value has consistently been at much lower levels. In fact, except for a slight deviation in 2007, the *H* values have closely tracked the *H* value that would resulted from an allocation of curtailment exactly in proportion to projects' nameplate capacity; i.e., *H* = .2245. This corroborates that curtailment has tended to be roughly proportional to generating capacity.

The *H* index shows an increase in 2007 suggesting a slightly less proportionate sharing of curtailment among projects in that year. This may have been prompted, in part, by the increase in curtailment that occurred during 2007, which was discussed earlier.

Compensation Among Participating Projects

Evidence of significant differences among projects in the amount paid per lost MWH might also provide some measure of whether discrimination has occurred. Table 1 provides calculations of the variance of dollars paid per lost MWh to each of the six participating projects for each year from 2003 through 2007. The variance value reflects the variability among the observed values. A larger variance value suggests greater variability among the observed values; in this, the amount paid per MWh. No difference in the amount paid per MWh among the six projects would produce a variance value of zero.

Year	Variance of curtailment $/MWh curtailed[6]
2003	640.068
2004	18.523
2005	11.944
2006	11.818
2007	14.934

The substantially larger variance for 2003 is probably due to start-up disparities when the curtailment protocol and payment values were being worked out. This degree of variance, continued over multiple years, would have warranted concern about discrimination. However, occurring as it did, in the beginning year of the new protocol, followed by consistently much reduced levels, substantially diminishes concerns about the prevalence of discrimination.

The variance values for the years 2004 through 2007 indicate there are differences among projects in terms of the per MWh amounts paid for curtailment. However, differences of this magnitude could be explained by differences in the contract terms independently negotiated by individual projects. In other words, variance values of 0.0 would not be expected for contracts that are independently negotiated.

CONCLUSION:

Although differences exist among the projects participating in the curtailment protocol, definitively determining whether these are due to healthy, independent, negotiations under competitive conditions, or market power and undue discrimination, is very difficult to do based on these data. The relatively short duration of significant discrepancies (seemingly limited to the start-up year) and markedly diminished magnitude of the discrepancies over subsequent years suggests that undue discrimination does not appear to be an explanatory factor.

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[6] Variance is a measure of variability in a group of numbers ($x_1, x_2 \ldots x_n$). Specifically, it is: $s^2 = \sum(x_i - \mu)^2/n\text{-}1$, where x_i is an individual observation, μ is the average of all observations counted, and n is number of observations counted.