BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF THE APPLICATION BY CROCKER WIND FARM, LLC FOR A PERMIT FOR A WIND ENERGY FACILITY AND A 345 KV TRANSMISSION LINE IN CLARK COUNTY, SOUTH DAKOTA, FOR CROCKER WIND FARM

SD PUC DOCKET EL-17-___

PREFILED TESTIMONY OF MARK THAYER
ON BEHALF OF CROCKER WIND FARM, LLC

December 15, 2017
I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, employer, and business address.
A. My name is Mark Thayer. I am an Emeritus Professor in the Department of Economics at San Diego State University, San Diego, California 92182.

Q. On whose behalf are you offering testimony?
A. I am testifying on behalf of Crocker Wind Farm LLC (“Crocker”), the Applicant in this proceeding.

Q. Briefly describe your educational and professional background.
A. I received my Ph.D. in Economics from the University of New Mexico in 1979. My field of expertise is environmental, natural resource, and energy economics. I am currently an emeritus professor in the Department of Economics at San Diego State University. I have thirty-five years of experience in both university and government service, and extensive experience integrating environmental- and energy-related matters into decision making at the state and federal level. I have published numerous research articles in professional journals such as the American Economic Review, Journal of Political Economy, Journal of Environmental Economics and Management, Land Economics, Natural Resources Journal, Journal of Urban Economics, Economic Inquiry, Journal of Sports Economics, and Journal of Human Resources. I co-authored the Lawrence Berkeley National Laboratory (“LBNL”) studies relating wind developments to residential property values. I have been a principal investigator on projects funded by entities such as the California Air Resources Board, California Energy Commission, U.S. Environmental Protection Agency, U.S. Geological Survey, the South Coast Air Quality Management District, the National Science Foundation, and numerous private entities. My recent research has focused on projects related to energy efficiency (both program development and evaluation) and the assessment of the impact of wind farms and solar photovoltaic energy on residential property values.
A copy of my curriculum vitae is provided as Exhibit 1.

II. PURPOSE OF TESTIMONY

Q. Describe your familiarity with the Crocker Wind Farm (the “Project”).
A. I conducted a review of academic literature pertaining to wind project development and its impact on property values for the Project. This review, titled “The Impact of Wind Power Projects on Residential Property Values in the United States: An Overview of Research Findings” (“Report”) is included as Appendix I of the Project’s Energy Facility Permit Application (“Application”).

Q. What is the purpose of your testimony?
A. The purpose of my testimony and my Report is to provide: (1) a summary of the two LBNL national hedonic studies that investigate the impact of wind facilities on nearby property values, including a summary of and response to criticisms of the these studies; (2) a summary of additional academic literature pertaining to the wind development/property value relationship in the United States; and (3) a summary and analysis of certain "alternative literature," asserting wind farms negatively impact property values.

Q. What exhibits are attached to your Direct Testimony?
A. The following exhibits are attached to my Direct Testimony:

- Exhibit 1: Curriculum Vitae


- **Exhibit 7:** Atkinson-Palombo, C. and B. Hoen (2014). "Relationship between Wind Turbines and Residential Property Values in Massachusetts." Joint report of the University of Connecticut and the Lawrence Berkeley National Laboratory.


Q. **What sections of the Application for the Project are you sponsoring?**

A. I am sponsoring the following portions of the Application:

- Section 9.7.1.2: Impacts to Communities (Property Values – Wind Farms; Property Values – Transmission Lines)


III. **LBNL STUDIES**

Q. **What are the LBNL Studies?**

A. The Lawrence Berkeley National Laboratory (“LBNL”) conducted two large-scale regression studies in 2009 and 2013 (collectively, the “LBNL Studies”) examining the impacts of wind farms on nearby property values. The LBNL Studies are the following:


- "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States" (B. Hoen, J.P. Brown,
The 2009 LBNL study focused on property value concerns for wind energy that fall into three categories. Each of these effects could impact property values and the effects are not mutually exclusive.

- **Area Stigma** – concern that surrounding areas will appear more developed.
- **Scenic Vista Stigma** – concern over decrease in quality of scenic vistas from homes.
- **Nuisance Stigma** – concern that factors that occur in close proximity will have unique impacts.

The 2013 LBNL study focused only on area stigma and nuisance stigma.

**Q. Please provide a brief explanation of the empirical methodology used to examine the impact of wind farms on nearby property values.**

**A.** The wind turbine/property value relationship was primarily studied using a statistical method called the Hedonic Price Model. The hedonic price model has been used by economists and real estate practitioners for over 40 years and has the following attributes:

- Uses actual market data to infer value – there is no attempt to appraise values.
- Designed to place an economic value on specific characteristics of a home (e.g., value of an additional bathroom, a pool, or view of wind turbines).
- Uses a large number of home sales (many thousands).
- Controls (holds constant) a large number of possibly confounding variables (everything under the sun).
- Uses data from a large area to obtain enough variation in all characteristics.
• Can use data from a restricted period of time (cross-sectional analysis) or an extended period of time (time-series analysis) – note that this latter case requires adjustment to constant dollars.

• Can be used effectively to appraise homes due to extensive data set – however, constantly updating the data set is expensive and time consuming.

• Hedonic pricing is essentially a very large "Paired Sales" analysis with sufficient home sales and controls.

The hedonic pricing model requires information on a large number of sales and corresponding sales prices and home characteristics, which include

• Quantity Measures (e.g., square feet of living area, lot size, number of bathrooms, bedrooms, etc.).

• Quality Measures (e.g., number of fireplaces, condition of home, presence of pool, air conditioning, scenic vista, etc.).

• Location Specific Variables (e.g., local school quality, demographics, socioeconomic status, distance to important activities, environmental quality measures, etc.).

• Variables of Interest (e.g., view of wind turbines, distance to wind turbines).

Either Qualitative Ratings (e.g. dominance of view of wind turbines) or distance to the nearest turbine at time of home sale is used to measure the possible dis-amenity from wind turbines.

The 2009 LBNL study used home sales data from ten areas surrounding twenty-four wind facilities in nine states. In total, 7,459 residential sales transactions (1,754 pre-announcement, 768 post-announcement/pre-construction, and 4,937 post-construction) were analyzed. The 2013 study utilized 51,276 home sales from 27 U.S. counties related to 67 wind facilities, and 1,198 home sales were within one mile of a wind turbine.
Q. Please provide a summary of the LBNL research findings.

A. The 2009 LBNL study determined that there was no significant impact to sale values of properties over time due to proximity of wind-energy project development. The 2013 follow-up study found no statistical evidence for differences in home values from pre- to post-construction. The LBNL Studies concluded that risks of property value impacts are often expected, but all research suggests that property value impacts related to view and distance are essentially zero. Specifically,

- **Area Stigma** – no statistical evidence that sales prices of homes near wind facilities are significantly affected by those facilities as compared to other homes in the region.
- **Scenic Vista Stigma** – no statistical evidence that sales prices of homes with a view of the turbines are significantly affected (i.e., stigmatized) even if the view is "extreme."
- **Nuisance Stigma** – no statistical evidence that sales prices of homes within a mile of the nearest wind turbine are significantly affected by those facilities as compared to other homes in the region.
- **Timing** – no statistical evidence of a trend in sales prices of homes near turbines that is consistent with scenic vista, area, or nuisance stigma.

In addition, the LBNL Studies also provided results from alternative models:

- **Repeat Sales Model** – appreciation rates for homes near the wind farms are not significantly different than appreciation rates for homes located farther from the wind farms.
- **Sales Volume Analysis** – no statistical evidence that the sales volume of homes near wind farms is different than the sales volume of homes located farther from the wind farms.

Q. Are there other peer-reviewed studies completed recently that examined the impact of wind farms on nearby property values in the United States?
A. Yes. In addition to the two LBNL Studies, there have been six large empirical studies completed since December 2009 that examined the impact of wind farms on nearby property values in the United States. The studies are:


- "The Effect of Wind Farms on Residential Property Values in Lee County, Illinois" (J. Carter), 2011 – analysis of 1,298 home sales. (Exhibit 5).

- "Impact of the Lempster Wind Power Project on Local Residential Property Values" (M. Magnusson and R. Gittell), January 2012 – analysis of 2,593 home sales. (Exhibit 6).

- "Relationship between Wind Turbines and Residential Property Values in Massachusetts" (C. Atkinson-Palombo and B. Hoen), 2014 – analysis of 122,198 home sales, with 6,081 within one mile of a turbine (Exhibit 7). Final published version of this work appeared in the peer-reviewed *The Journal of Real Estate Research*. (Exhibit 13).


Q. Please provide a summary of these studies.

A. The studies included in my literature review (Appendix I) utilized generally accepted statistical analysis, implying the data base was sizeable (thousands of observations, i.e., utility scale operations), used market data, and used accepted methodologies.
(e.g., hedonic price method). These studies all come to the same conclusion. Specifically all large-scale, empirical studies of U.S. wind facilities conclude that, post-construction/operation, there is no identifiable effect of wind power projects on nearby residential property values. This conclusion is based on the evaluation of 248,560 actual home sales in eight studies.

While three of the studies included in my review suggest that there is some evidence that the post-announcement/pre-construction phase of wind facility development could have a negative effect on nearby property values, this has been labeled “anticipation stigma” and the effects are small and dissipate completely after the facility is operational. Based on this extensive literature, the planned wind projects in South Dakota will not significantly reduce the sales prices of properties around the wind facilities.

Q. **Please describe how community characteristics affect real estate price trends and hedonic method estimates.**

A. Community characteristics could have either positive (e.g., expanding population, expanding economic opportunities, etc.) or negative (de-population, lack of jobs, abandoned homes, etc.) effects upon housing price trends. In either case, these characteristics should not prevent good statisticians from determining the value/cost of proximity to a turbine or having a view of a turbine because the comparison is between homes near to turbines versus homes far from turbines, homes with views versus homes without views, etc.

Q. **Are you aware of any studies that have found a connection between wind turbines and property values?**

A. There are no large-scale statistical studies completed using data from areas in the United States and/or Canada that consistently show a significant negative impact from wind facilities on nearby property values after the wind facility is constructed and operable.
There have been some studies that indicate there could be a potential negative impact to property values within or near a wind farm project area, such “studies” use inappropriate statistical methods such as small sample sizes, non-transparent sample selection process, failure to control for obvious variables, failure to understand statistical significance, or were not subject to peer-review. Examples include a study from Gardner (Gardner, 2009) and Kielisch (Kielisch, 2011). Additionally, there have been European and United Kingdom studies that show possible negative property value impacts from wind facilities, but the estimated impacts are small (3-7%) (Sunak and Madlener, 2012; Jensen et al., 2014; Gibbons, 2014). Further, these impacts cannot be explained by data size, quality, or estimation methods and, therefore, have led to speculation that community involvement and compensation levels differ from standard practice in the United States and Canada. As a result, it is questionable that these studies are relevant to an analysis of property values in the United States.

Finally, there is a recent paper (Heintzelman, Vyn, and Guth, 2017) (Exhibit 10) that examines the impact of wind turbines on nearby property values on both sides of the United States/Canada international border. This paper finds inconsistent results. There are no significant property value impacts on the Canadian side of the border for either turbine view or proximity to turbines. On the US side, there are indications of negative property value effects, primarily for turbine view. The results for the proximity to turbine variables generally do not support the turbine view results as neither the full sample nor the restricted 10 mile sample show negative property value effects. The authors do not provide a definitive rationale for the overall results disparity (Canada v. U.S., turbine view v. proximity) but do offer some speculation about when negative effects might be expected. These include the quality of view prior to turbine construction, the relative quantity of vacation homes and/or waterfront properties, the level on involvement by the local residents, and the level of compensation to the local community. The implication seems to be that if the view prior to construction is not of water, if there are relatively few vacation or waterfront homes, if local residents are active participants in the turbine facility development,
and if there is some positive compensation to the local community then there will be no negative impacts on nearby property values from wind developments. There are likely few situations in which this restrictive combination of attributes occurs. This may help explain why all other United States and Canadian studies have failed to find significant property value impacts.

Q. What your thoughts regarding the work of Michael McCann with respect to analyzing the potential impact of wind facilities on property value?

A. The “alternative literature” discussed in response to the prior question has formed the basis for Michael McCann’s study of wind facilities and property values. Mr. McCann has offered the same testimony in a multitude of settings – specifically, that residential properties located within three miles (or possibly greater distances) of wind turbines will experience a minimum 25-40 percent reduction in home value. Overall, Mr. McCann’s studies are cursory investigations using raw averages and paired sales methods. Each of these analyses is beset with the same range of problems, including: small samples; undefined sample selection methods; simple statistical measures; failure to account for obvious confounding factors; and subjective monetary adjustments applied inconsistently. Given these fundamental issues, the conclusions of such work are without foundation and completely lacking in scientific rigor.

Moreover, Mr. McCann’s results are based on specific locations, specific local influences, and specific adjustment factors. As a result, even if the studies had been done with appropriate scientific rigor, they would not be transferable to any other situation. Further, only one assessment procedure is provided, one that always agrees with his previous work and never explores the impact on his conclusions of different samples, different selection methods, and/or different adjustment factors.

Q. Should such studies be given the same weight as the LBNL Studies?

A. No. These studies do not possess the required scientific rigor. These studies use inappropriate statistical methods, such as small sample sizes, non-transparent
sample selection process, failure to control for obvious variables, and/or failure to understand statistical significance, and often were not subject to peer-review.

Q. Do wind farms have the same impact on property values as transmission line?
   A. Crocker also reviewed the impact of transmission lines on property values. Jackson and Pitts (2010) conducted a literature review highlighting several studies. (Exhibit 19). Studies reviewed were empirical studies between 1964 and 2009. The studies reviewed, while having some inconsistencies in their detailed results, generally pointed to small or no effects on sales price due to the presence of electric transmission lines. Some studies found an effect, but this effect generally dissipated with time and distance. The effects that were found ranged from approximately 2% to 9% (Exhibit 19) within very close proximity to the transmission line (e.g., 500 feet). While this study indicates a small effect on property values is possible, if the transmission line avoids residences, impacts to property value are not anticipated.

Q. Are you aware of any studies that look at the impact of wind turbines on property values in South Dakota specifically?
   A. No. None of the previous academic research, nor for that matter, any of the "alternative literature," has included South Dakota wind projects.

Q. Please describe the relevance of national studies, such as the LBNL Studies, to the Project?
   A. Because none of the previous academic research or alternative literature on the impact of large-scale wind farms on nearby property values has included South Dakota wind projects, to predict what might occur near South Dakota wind facilities requires the transfer of existing research from similar areas. The LBNL studies were not confined to strictly agricultural areas, but did include areas very similar to the South Dakota county in which the Geronimo Project is planned. Specifically, Clark County is quite similar to its Minnesota counterparts, especially Cottonwood County, MN and Jackson County, MN. Franklin County, IA and Sac County, IA are also quite
similar to the South Dakota county. So, the range of counties studied in the LBNL includes counties like those in South Dakota.

Table 1 below summarizes information from counties studied in the 2009 LBNL study (top set of counties) and the 2013 LBNL study (middle set of counties), and compares the same information for Clark, Codington, and Grant Counties in South Dakota. The table provides data on the following area attributes: population; population per square mile; median age (from 2014); median income (2013); and median home value (2013).

Table 1: Comparative Data

<table>
<thead>
<tr>
<th>County</th>
<th>State</th>
<th>Population</th>
<th>Population/mi²</th>
<th>Median Age</th>
<th>Median Income</th>
<th>Median Home Value</th>
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<td>40</td>
<td>55,287</td>
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<td>NY</td>
<td>72,369</td>
<td>110</td>
<td>39</td>
<td>52,300</td>
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<tr>
<td>Umatilla</td>
<td>OR</td>
<td>76,705</td>
<td>24</td>
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<td>48,514</td>
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<td>Somerset</td>
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<td>43,429</td>
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<td>Howard</td>
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<td>39.5</td>
<td>$49,342</td>
<td>$132,510</td>
</tr>
</tbody>
</table>

<p>| Carroll  | IA    | 20,562     | 36             | 42         | 50,074        | 107,911          |
| Floyd    | IA    | 16,077     | 32             | 43         | 44,152        | 92,087           |
| Franklin | IA    | 10,436     | 18             | 42         | 48,715        | 89,330           |
| Sac      | IA    | 10,035     | 17             | 46         | 48,451        | 81,367           |
| DeKalb   | IL    | 105,462    | 166            | 29         | 52,867        | 160,600          |
| Livingston | IL   | 37,903     | 36             | 40         | 55,287        | 102,523          |
| McLean   | IL    | 174,06     | 147            | 32         | 61,846        | 160,300          |
| Cottonwood | MN   | 11,633     | 18             | 44         | 45,949        | 83,197           |
| Freeborn | MN    | 30,840     | 44             | 44         | 46,698        | 99,683           |
| Jackson  | MN    | 10,629     | 15             | 44         | 52,428        | 93,644           |
| Martin   | MN    | 20,220     | 29             | 45         | 51,865        | 98,341           |
| Atlantic | NJ    | 275,209    | 491            | 39         | 52,127        | 218,600          |
| Clinton  | NY    | 81,633     | 79             | 39         | 43,892        | 121,200          |
| Franklin | NY    | 51,262     | 31             | 39         | 45,580        | 93,529           |
| Herkimer | NY    | 63,744     | 45             | 42         | 43,754        | 89,098           |
| Lewis    | NY    | 27,220     | 21             | 40         | 47,990        | 103,257          |</p>
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<th>Median Income</th>
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<td>18.7</td>
<td>42.3</td>
<td>$47,742</td>
<td>$106,030</td>
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In general, the South Dakota counties seem to have lower average population/mi², median income, and median home value than the average county in either the 2009 or 2013 LBNL studies. However, with respect to other demographics and land use, the South Dakota counties are similar to those included in the 2009 and 2013 LBNL studies evaluated. Of the 36 unique counties examined, 21 are considered more than 50 percent rural, whereas only four counties (Benton, WA; Walla Walla, WA; DeKalb, IL; Atlantic, NJ) are less than 22 percent rural. Sixteen unique counties have a percentage rural greater than or equal to 59 percent, the raw average of the South Dakota counties. Sac County, IA is considered 100 percent rural, which is the same as Clark County, SD. Additionally, Clark County’s land cover is 26 percent pasture land and several counties that were examined have land cover dominated by pasture land (over 50 percent) including Grady, OK; Custer, OK; Kittitas, WA; and Howard, TX. Therefore, the range of counties studied in the LBNL includes counties like those in South Dakota.

Given the information about the types of facilities planned and the previous research on like counties, we would be confident that the LBNL studies would be a reasonable source for a benefit transfer (or damage transfer) effort to South Dakota. This leads to the overall conclusion that the planned wind project in South Dakota
will not significantly reduce the sales prices of properties in the neighborhood of the wind facilities.

IV. CONCLUSION

Q. Does this conclude your direct testimony?
A. Yes.

Dated this 15th day of December, 2017.

Mark Thayer

Digitally signed by Mark Thayer
DN: cn=Mark Thayer, or=San Diego State University, ou, email=mthayer@mail.sdsu.edu, c=US
Date: 2017.12.15 10:41:58 -08'00'