Appendix F: Literature Review of Socioeconomic Effects of Wind Project and Transmission Lines

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Literature on Property Value Impacts of Wind Projects

The economic effects of wind energy projects have been well documented. Several studies that have evaluated potential property value impacts are highlighted below (organized chronologically). No clear inference can be drawn from these studies and available research as the analyses vary in terms of rigor; methodology (e.g., survey sampling, statistical analysis, and expert opinion); size, location and site character of projects analyzed; and results and conclusions. However, the preponderance of research on this issue suggests that there is no negative relationship between wind energy developments and property values.

1. Jordal-Jorgensen, J. (1996). "Visual Effect and Noise from Windmills – Quantifying and Valuation. "Social Assessment of Wind Power in Denmark. The Institute of Local Government Studies (AKF). April 1996.

The first empirical study specifically addressing the potential impact of wind turbines on property values was based on property values in Denmark in 1996. In this study, the opinions of homeowners were used to derive a monetary value (in 1996 Dutch Kroners) for two contingencies. First, 342 homeowners living “near” windmills in Denmark were asked if they find windmills a nuisance, and if so, how much would they be willing to pay to have them removed. A total of (13%) homeowners from the sample of 342 thought that windmills were indeed a nuisance, and collectively they were willing to pay the equivalent of $140 (1996 US Dollars) annually to have them removed. Secondly, the same 342 homeowners were asked to indicate how much they would be willing to pay to NOT live near a windmill. Of the 26 homeowners (%) who provided a nonzero response to this question, the price they would be willing to pay to not live “near” a windmill ranged from an equivalent $2,314 to $13,429 (1996 US Dollars). The term “near” remained subjective and undefined in the survey. It was inferred by the author that house values were lower when in close proximity to windmills than for other houses located further away. The lack of statistical controls with respect to this study’s sampling, definition of terms, and analysis render its results anecdotal at best. The author candidly admits that the small number of houses located near the wind turbines, coupled with the low proportion of that group who responded to the survey questions, produce a result that is in no way statistically significant and could be "due to coincidental factors".

2. Grover, D. S. (2002). "Economic Impacts of Wind Power in Kittitas County, WA. " ECONorthwest for Phoenix Economic Development Group. 1-18. November 2002.

The first comprehensive look at the impact of wind turbines on property values was conducted in 2002 by ECONorthwest for a proposed wind turbine project in Kittitas County, Washington. This study is notable for segmenting the broader economic impacts of wind turbines into now familiar categories: property values, economic impacts and tax revenues. The property values section of their study consisted, in turn, of two separate analyses. First, they interviewed 13 county tax assessors from the 13 counties where a total of 22 wind turbines had been installed in the previous ten years. Six of those counties had residential properties that were in view of the turbines, another six had no residential properties in view of the turbines, and the 13th county had not completely installed its wind turbines to make a determination regarding the view shed. Assessors in five of the six counties with residential views stated that they had not determined any negative impact on property values. Hoen (2006, page 8) concludes in his review of this study that "…the fact that residents did not complain (correlation) does not mean conclusively that property values are not affected (causation)". The second strategy employed by ECONorthwest to assess the impact of wind turbines on property values was a literature review of peer-reviewed journal articles. Their review found only the 1996 Danish study by Jordal-Jorgensen (see above item #1) meeting their criteria for inclusion.

3. Sterzinger, G., F. Beck, et al. (2003). "The Effect of Wind Development on Local Property Values." Renewable Energy Policy Project. 1-77. May 2003. http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf [Viewed 8-11-08].

Probably the best known wind farm study, and certainly the most rigorous up to that time, appeared in 2003. The Renewable Energy Policy Project (REPP) studied ten wind farm projects located in California, New York, Texas, Vermont, Wisconsin, Pennsylvania, and Iowa. They used monthly property sales data to answer three related research questions: (1) how did prices change over the entire period of the study for sales occurring in the viewshed and outside of the viewshed of the turbines. The viewshed was defined as a five-mile radius beginning at the point of the outermost turbine; (2) how did prices change within the viewshed before and after the projects came on-line; and (3) how prices changed for both the viewshed and a comparable region, but only for the period of time after the turbines came on-line. The comparable areas used as controls for this third question were defined as reasonably close communities with similar demographic, economic, and geographic characteristics and trends compared to properties within the viewshed, but located outside of any wind turbine viewshed area.

The REPP researchers used simple regression analysis to estimate how the rate of property value change was affected in each of the cases. The study found no significant empirical support that property values were diminished in any of the ten case studies from around the country. Interestingly, the study also found that for most of the project areas the property values rose more quickly in the viewshed than they did in the comparable community; that values increased faster in the viewshed after the projects came on-line than they did before; and finally, that after projects came on-line, values increased faster in the viewshed than they did in the comparable community. For 26 of the 30 individual scenarios analyzed, property values in the affected viewshed rose more than in comparable communities.

While this study is often quoted, it has been criticized methodologically along four different lines: (1) no attempt is made to discern which of the properties within a 5-mile viewshed can actually see the windfarm; (2) the viewshed impact is categorical, in that no attempt is made to control for distance to the turbines. That is, the viewshed "impact" is the same, whether the property is adjacent to the windfarm or farther away (up to five miles); (3) the sole reliance on the R^2 statistic is flawed, especially when very low values of that statistic are relied upon; and (4) the universe of property transactions was analyzed without further refinement or filtering out of those transactions not occurring "at will", due to such circumstances as estate sales, divorce, sale to family members, etc. (Hoen 2006, p16-17).

4. Haughton, J., D. Giuffre, et al. (2004). "An Economic Analysis of a Wind Farm in Nantucket Sound." Beacon Hill Institute at Suffolk University. 2-83. May 1, 2004 http://www.beaconhill.org/BHIStudies/Windmills2004/WindFarmArmyCorps.pdf [Viewed 8-11-08].

Shortly after release of the above cited REPP study, citizen groups opposed to development of a windfarm in Nantucket Sound coalesced around researchers Haughton and Giuffre and David G. Tuerck's Beacon Hill Institute, commissioning a survey of 45 real estate agents and 501 residents of Cape Cod and Martha's Vineyard. While this study was the first survey of the impact of windfarms on property values in the US since the 1980's, its publication was met with a polarized reception based on its findings.

The study concluded, perhaps prematurely, that the presence of a large scale windfarm on Nantucket Sound could be perceived as a loss in amenity value. Twenty-one percent of the residents and 49% of the realtors reported a negative, adverse expectation of property value decline. For the resident group, the 21% with negative expectations thought that property values would decline by between 4% and 10%, with the higher amount reflected along waterfront property. The 49% of realtors with negative expectations thought values would decline an average of 4.6%.

As late as 2007, the results of this opinion study have been utilized by opponents of windfarms. In an article written by journalist Wendy Williams, she quotes one extrapolation of the study's findings: "It is estimated that property values in the six affected towns would fall by 4 percent. This represents a loss of $1.35 billion in property values, or almost twice the cost of the windmill project". Williams then elaborates on the methods used by the Beacon Hill Institute when interviewing local residents: "…Tuerck's surveyors showed 501 homeowners in the six towns around the Sound photo simulations of what the offshore wind project would allegedly look like from their homes. Then the team asked homeowners if they thought their properties might drop in value once Cape Wind was built. Sampling a group that has been constantly assaulted with doom-and-gloom anti-windfarm hysteria for several years is unlikely to yield a useful result. Even so, 79% of interviewees said they did not expect a drop in home value – a fact which is not mentioned in the Institute's summary and study analysis". Wendy Williams is co-author, with Robert Whitcomb, of Cape Wind: Money, Celebrity, Class, Politics and the Battle for Our

Energy Future on Nantucket Sound. The Op-Ed piece cited above appeared Providence (Rhode Island) Journal, June 27, 2007.

The important contribution of this study is that it attempts to legitimize perceived declines in property values as worthy of analysis in its own right, thus evading criticism that such perceptions may or may not reflect actual changes in property values. In subsequent years, the pursuit of documentation regarding perceptions about property value impacts remains as strong as the pursuit of documentation regarding the impact of windfarms on actual property values and transactions.

5. DeLacy, P. Barton. A LULU of a Case: Gauging Property Value Impacts in Rural Areas. Real Estate Issues, Fall 2004.

Both chronologically and substantively, Barton DeLacy's article for the online journal Real Estate Issues marks the next significant contribution to our understanding of this issue. While his article is not an empirical review of any particular wind turbine project, it represents the reflections and views of an experienced researcher.

DeLacy includes windfarms within the group of Locally Undesirable Land Uses (hence the acronym LULU), exemplified by prisons, landfills, power transmission lines, and toxic waste sites. All of these land uses, when initially proposed, can trigger environmental impact statements (EIS, EA, etc.) and elicit excruciatingly detailed public information based on attitude, opinion, perception, expectations, and the like. Experts, he says, are asked to provide a before-and-after valuation theory to a particular affected area for a particular proposed land use, often without access or reference to empirical market transactions. Particularly in rural areas, where the number of residential properties is low to begin with, the corresponding ratio of actual transactions is even lower, with the number of such transactions occurring in close proximity to the LULU approaching zero.

Case studies of LULU's in urban areas have established that stigma, noise, and even toxic emissions do not influence property values much beyond a two-mile radius, while negative perceptions and attitudes about the LULU might suggest otherwise. For rural areas, and with particular reference to windfarms, he makes the point that land most nearly adjacent to the LULU is usually provided a lease or other compensation, with buffers and restrictions extending the proximity of residential structures to beyond one mile.

DeLacy further legitimizes the concept of stigma and other perceived impacts as legitimate concerns that impact the marketability of a property. Stigma (what can (cannot?) be seen, smelled, heard, etc.) has much more to do with reputation and with the intangible components of human desire than with easily measured variables including distance, line of sight, earshot, etc.

He further distinguishes the impact of stigma from a LULU on residential properties in a rural setting from a LULU on primarily agricultural properties in the same setting. Whereas residential property is sensitive to nuance, reputation, and other intangibles connected with mountain views, access and frontage on a stream, and the like, farmland is bought and sold based on its productivity and utility. Farmland, because of its expanse and comparatively lower unit values (compared to urban land) has seldom been found to be affected by structures, so long as no material damage can be shown. Farmland does lose value if its water rights are revoked or its soil turns fallow. The presence of transmission towers or windmills does not adversely affect value because the parcels are too large with too low a unit value to be sensitive to that type of influence. In addition, the lease arrangements that typically involve large parcels of agricultural private land for such structures provide the owner with compensation far in excess of any calculated production value for the acreage involved.

He concludes his article with three generalizations: (1) Property values seem resilient, particularly in areas with sustained population growth; (2) the value of large parcels in agricultural use (multiple acreage) seem far more likely to be affected by production and transaction factors (like the availability of water and the costs of mortgage financing) than indirect impacts from LULU's; (3) property values in rural areas will be most affected by local employment and the presence of recreational opportunities.

6. Poletti, P. (2005). "A Real Estate Study of the Proposed Forward Wind Energy Center Dodge and Fond DuLac Counties, Wisconsin." Prepared for Invenergy Wind LLC. May 2005. http://psc.wi.gov/apps/erf_share/view/viewdoc.aspx?docid=35184 [Viewed 8-12-08].

The purpose of Poletti's report was to determine if the proposed Forward Wind Energy Center is located so as to minimize any adverse effect on the character of the surrounding area and on surrounding property values. The study area consisted of Dodge and Fondulac counties of Wisconsin, and a broader, "control area" extending into Illinois. The analysis was based on expert opinion and relied on a detailed review of the subject property and plans for the proposed wind energy center; on-site inspection of the subject property and surrounding area; inspection of other wind development sites; a review of uses and property values of surrounding tracts of land, including data on real estate transactions; and discussion with various assessors.

Poletti's analysis does cull out transactions that were not arms-length, thus improving on the methodology of Sterzinger, et. al. (2003). It also excludes sales of homes built before 1960 in an effort to control for house-specific characteristics such as construction quality, amenities and condition. Poletti examined roughly 300 sales that occurred in and around the two windfarms. He comes to the cautious conclusion that "there is not sufficient evidence in the data to warrant rejection of the claim that windfarms have an effect on property values." Any effect that is evidenced in the study, however, would seem to suggest an overall positive, though insignificant impact.

Poletti compares average values of properties surrounding the windfarms, which he entitles the "target area", with those in a "control area" which is outside the view of the windfarm. However, Poletti does not attempt to measure to what degree, if any, homes can actually see the windfarm. The author describes the area surrounding the windfarms as rolling with potentially obscuring features, so the implication is that some of the properties in the "target area" have no view of the windfarm. Further, no effort is made to control for distance from the windfarm.

This study is notable for the rigor and expertise brought by the author, who has wide professional experience evaluating changes in residential property values resulting from windfarm and other developments. Poletti's methodology resists the opportunity to over-use the available transaction data. For example, he is criticized by Hoen (2006) for not controlling for distance to a turbine, even though such controls would render his otherwise statistically sound techniques unreliable due to diminishing cell sizes.

7. Hoen, B. "Impacts of Windmill Visibility on Property Values in Madison County, New York", Submitted to the Faculty of the Bard Center for Environmental Policy. Prepared in partial fulfillment of the requirements for the degree of Master of Science in Environmental Policy, Bard College, April 30, 2006.

Hoen's M.A. thesis represents the most statistically rigorous analysis of property value effects from wind energy projects to date. Its methods were later refined in a series of ongoing continuation studies that are reported here as Wiser and Hoen (2007), below. This study is also notable for its thorough review of the literature and its careful treatment of methodological and definitional issues.

Hoen's study focuses on the property value impacts of the Fenner wind energy project in Madison County, New York. It analyzed 280 arms-length single-family residential sales in the vicinity of the proposed wind development using a hedonic regression model. The sales occurred between 1996 and 2005 (140 transactions occurred after facility construction began in 2001) and were within 5 miles of the 20 turbines/30 megawatt (MW) wind development. None of the home sales were on properties that contained turbines, and none of the properties were compensated for the operation of the turbines. This study is unique in that all properties in the database were visited to "ground-truth" the actual level of turbine visibility.

The hedonic regression model focuses on two key characteristics: view of and distance from turbines, and combines them with a number of house and neighborhood characteristics to estimate the specific effect on home sales prices of the view of and distance from turbines. Although the model provides a strong statistical explanation of home values, the analysis concludes that there are no statistically-measurable effects of wind farm visibility on property values, even for those properties located within one mile of the facility and those that sold immediately following the announcement and construction of the wind farm.

Despite its methodological rigor, careful literature review, and treatment of a wide range of definitional issues, opponents of windfarms have attacked the study as "a college kid's thesis" and advised Mr. Hoen to "go back to Statistics 101". To date the scientific and professional community has been less critical of his study.

8. DeLacy, P. B. "Impacts of The Dairy Hills Wind Farm Project on Local Property Values". Technical Memorandum prepared for Dairy Hills Wind Farm, LLC and the Town of Perry, by Cushman & Wakefield, Inc. May 26, 2006, File No.: 06-34001-9104. Copy available via internet through third party archival source: http://www.maine.gov/doc/mfs/windpower/pubs [Viewed 12-3-08]

   DeLacy, P. B., "Evaluating Impacts of Wind Power Projects on Local Property Values". Technical Memorandum prepared for UPC Wind Management, LLC and the Cohocton Planning Board, by Cushman & Wakefield, Inc. November 17, 2006. File No.: 06-34001-9569B. http://www.dutchhillwind.com [Viewed 8-15-08].

These two technical memoranda are publicly available illustrations of the research approach taken by P. Barton DeLacy, a nationally known consultant, currently of Cushman & Wakefield of Oregon, Inc. The first of the two research illustrations involves the Dairy Hills windfarm, located near the towns of Covington, Perry, and Warsaw; all in Wyoming County, New York. The Dutch Hill project focuses on an area around the town of Cohocton in Steuben County, New York.

In both cases, DeLacy's contracted work is submitted as a Technical Memorandum and Appendix to the EIS connected with the respective windfarm proposals, and his methodological approach remains consistent. They are included in this review of literature for two reasons: (1) they have been involved in numerous assessments of the property value impacts of windfarms; and (2) their approach focuses on assessing property value impacts in sparsely populated and rural areas. Rural and sparsely populated areas are not amenable to the preferred statistical methodologies involving regression analysis, which in turn require a very large volume of property transactions for their proper use.

The methodological approach involves four dimensions of information gathering and analysis: (1) Review of the dominant literature pertaining to the property value impacts of windfarms and wind turbines, with particular emphasis on identifying and applying aspects of that literature with strongest bearing and utility for the study at hand; (2) Review of the numerous Technical Memoranda conducted by both their own firm and by other firms, with emphasis on defining commonalities between and among the findings pertaining to sites most similar to the study at hand; (3) a thorough analysis of local property transactions within the windfarm viewshed going back at least two or three years; onsite inspections of all properties bought and sold; collection and analysis of building permits, construction patterns, and land sales and leasing patterns occurring over several recent years within the siting area; and (4) demographic profiling of the area's population, labor force and employment, industry base, and general economic conditions.

9. Economic Impacts of the Hatchet Ridge Wind Project. Prepared for Hatchet Ridge Wind, LLC, a subsidiary of RES Americas Inc. 700 SW Taylor St. Suite 210, Portland, OR 97205. Prepared by Economics Group of ENTRIX, Inc., 12009 N.E. 99th Street, Suite 1410, Vancouver, WA 98682-2497, November 5, 2007.

A recent windfarm development is underway in the rural portion of eastern Shasta County, California. Early scoping documents do not include a systematic or empirical review of either actual property sales transactions or surveys of local real estate professionals and assessors. The project is nonetheless included in this review because of its location in a sparsely settled rural area of the northwest is similar to that of the China Mountain area.

To date, the approach taken by ENTRIX has been exploratory, relying heavily on insights to be gained from a thorough literature review, coupled with ongoing appreciation of the conflicting pressures on local property values obtained from community input and field inspection.

The Project would be sited entirely on private lands that are currently in timber production. The value of these lands would be influenced by the reduction in timber production (downward pressure) and long-term lease revenues (upward pressure). It is likely that the net effect of these offsetting factors is positive.

For properties located in proximity to the proposed wind energy development, the two key issues are visual and noise impacts. Noise impacts have been cited as a concern with wind projects generally, but noise effects are generally limited to properties with turbines, whose property values typically increase as a result of long-term revenue streams from leases. In the context of visual impacts, assuming scenic values are incorporated or "internalized" into the existing value of properties in the Project area, there is the potential for downward pressure on property values if wind facilities are perceived to adversely affect the quality of viewshed, it being recognized that some find the view of wind turbines to be appealing There is likely greater internalization of scenic values on residential properties compared to undeveloped land in agricultural uses, such as grazing.

Conversely, they note, there are also sources of potential upward pressures on nearby property values emanating from wind energy developments. First, these projects offer both short- and long-term economic benefits in the region, including job and income creation, as well as future economic development opportunities associated with expanded infrastructure and a new power source. Second, wind developments may boost tourism to the area, thereby promoting regional economic development. Finally, the Project would provide long-term revenue streams as lease payments to property owners on whose land the Project facilities would be located. In summary, there appear to be conflicting pressures on property values from wind energy developments. The manner in which these pressures would interact for the Hatchet Ridge Project is unknown, and data are not sufficient to quantify the property value effects of the proposed Project

The ENTRIX team currently poses two key questions in their effort to better understand the effect of this wind energy project on Shasta County property values: (1) To what degree have scenic values been internalized in local residential property values? (2) How would the Project affect the scenic quality of the area?

10. Hoen, Ben, Ryan Wiser, et al., "The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis," Lawrence Berkeley National Laboratory, Berkeley, CA, December 2009.

Following completion of his M.A. thesis in 2006, Ben Hoen joined Ryan Wiser at the Lawrence Berkeley National Laboratory to continue investigating the existence and composition of property value effects surrounding wind energy facilities in the United States. The authors have refined Hoen's 2006 hedonic regression model and extended their research to 10 communities surrounding 24 windfarm sites in nine states. The wind farms represented 13% of the existing wind generating capacity of the U.S. in 2005. They created ten hedonic models that measure the individual contribution of specific housing characteristics to property values. This is the most comprehensive and data-rich study of the effects of wind projects on residential property values done to date.

Their method utilized field visits to each of 7,459 homes experiencing a property transaction over the last 10 years, testing for the three effects of area stigma, scenic vista stigma, and nuisance stigma. They examined the effect of repeat home sales and looked for effects on home sales volumes. Homes ranged from 800 feet to over five miles from projects. They tested for the quality of the scenic vista and for the degree to which wind turbines were visible. They even tested for the orientation of the house toward the wind project. Their extended research found no effect on transaction value for the three types of stigma defined in the study. Here are their conclusions:

> "Although each of the analysis techniques used in this report has strengths and weaknesses, the results are strongly consistent in that each model fails to uncover conclusive evidence of the presence of any of the three property value stigmas. Based on the data and analysis presented in this report, no evidence is found that home prices surrounding wind facilities are consistently, measurably, and significantly affected by either the view of wind facilities or the distance from the home to those facilities. Although the analysis cannot dismiss the possibility that individual or small numbers of homes have been or could be negatively impacted, if these impacts do exist, they are either too small and/or too infrequent to result in any widespread and consistent statistically observable impact. Moreover, to the degree that homes in the present sample are similar to homes in other areas where wind development is occurring, the results herein are expected to be transferable."

Literature on Economic Impacts of Wind Projects

While several of the above studies, such as Hatchet Ridge, include estimates of economic impacts, the following articles are reviewed for the information they offer about the economic impacts of wind projects and the wind power industry.

11. "Economic Impacts of Wind Energy Projects in Southeast Washington," Prepared for Southeast Washington Economic Development Association. Prepared by Economics Group of ENTRIX, Inc., 12009 N.E. 99th Street, Suite 1410, Vancouver, WA 98682-2497, March 6, 2009.

    This report by the Entrix team looked at three wind projects totaling 367 MW built in Columbia County near Dayton, Washington, with impacts examined in four counties in southeast Washington. They found that the projects generated a total of 189 jobs during construction, and 53 jobs during operations, including direct, indirect, and induced impacts. The report notes that rural Columbia County retained a small minority of the construction jobs with most going to the regional urban centers outside the county. Most operations employees do reside locally. The projects generated $4,837,000 in property taxes in 2008 for Columbia County taxing districts. Operations generated $3,081,000 in direct impacts, and $3,465,000 in total impacts annually.

    They found no data to support any impacts on property values, recreation, or community services coming from interviews with park, land, and infrastructure managers. Hunting continues in the area. Group tours of projects resulted in 600-800 visitors per year, with that number growing over time. The study concludes that while economic multipliers are low, the wind projects do confer benefits to the region and the degree to which benefits are captured locally depends on the proximity of the project to regional retail centers.

12. Grover, Stephen, "Economic Impacts of the Desert Claim Wind Project," Prepared for the enXco Company by ECONorthwest, 888 SW Fifty Avenue, Suite 1460, Portland, OR 97204, April 21, 2009.

This report analyzes a project in Kittitas County, Washington consisting of 95 turbines with a nameplate rating of 190 MW. The report confines itself to economic and fiscal impacts. The analysis relies heavily on secondary data, developing construction costs based on the DOE estimate of $1,920/kW cited in number 11 above, and run through the Jobs and Economic Development Impact (JEDI) cost model developed by the National Renewable Energy Laboratory (NREL). IMPLAN is then used to generate indirect and induced impacts. Construction of the project is estimated to create 282 jobs in total, with additional economic impact to the economy of $33 million. They estimate that 12 jobs will be created directly for operations, for a total of 36 jobs with indirect and induced impacts. Rental payments to private landowners for 40 MW are estimated to generate $600,000 per year in lease payments, and they estimate 76% of this will be spent locally using historical household spending patterns as the guide. Their estimate of $1,832,846 in annual fiscal impacts includes lease payments for turbines on state land and estimated impacts to state coffers.

13. Goldberg, Marshall, The Jobs and Economic Development Impact Model (JEDI), National Renewable Energy Laboratory (NREL), Golden, Colorado, http://www.nrel.gov/analysis/jedi

The JEDI model was developed in 2006 to calculate the economic impacts associated with wind power development. It relies on IMPLAN state coefficients to develop indirect and induced impacts. These coefficients are aggregated into 14 sectors of the economy. The direct impacts are inferred from a few simple parameters of the project, using default expenditure patterns taken from past wind power projects, and local purchase shares derived from past projects and reviewed by wind developers. The model is comprehensive in estimating financing costs and fiscal impacts as well. These default values can be overridden where better local information is available. As the model has been improved from a growing data base of actual wind projects, it is moving toward its objective of becoming a benchmark technique for easily estimating economic impacts.

14. Torgerson, Melissa, Bruce Sorte, and Tim Nam, "Umatilla County's Economic Structure and the Economic Impacts of Wind energy Development: an Input-Output Analysis," Special Report 1067, Oregon State University Extension Service, March 2006.

This study analyzed the economy of Umatilla County in northeastern Oregon. However, its real contribution was to compare several approaches to estimating the economic impacts of a hypothetical 50 MW wind project. They used the JEDI model calibrated to State of Oregon regional purchase coefficients (RPCs), the JEDI model calibrated to Umatilla County with IMPLAN RPCs, a version of IMPLAN with local RPCs edited to reflect local conditions, and an "optimized" IMPLAN model that looked to a future economy more poised to capture the spending of the wind industry. The last model was an attempt to address the weakness IMPLAN has with its fixed technology assumptions, and to demonstrate the benefits that could occur in a county trying to capitalize on wind investments. As expected, the JEDI model with state coefficients had higher impact estimates because more spending is captured in the state's economy than in the small rural region. The edited IMPLAN and the JEDI model with local IMPLAN coefficients performed similarly. The authors encourage users to adapt either of these off-the-shelf models with as much local knowledge of the economy and of the project specifics as possible.

15. Ayee, Gloria, Marcy Lowe, and Gary Gereffi, *Manufacturing Climate solutions: Carbon-Reducing Technologies and U.S. Jobs*, Chapter 11: "Wind Power: Generating Electricity and Employment," Center on Globalization, Governance, and Competitiveness, Duke University, September 22, 2009, www.cggc.duke.edu/environment/climatesolutions

This study provides a good overview of the development of the wind power industry. It provides a detailed analysis of the supply chain for wind turbine manufacturing, the engineering and materials issues for improving wind technology, the firms involved in turbine manufacture, component manufacture, turbine transport, project development, and project operations and maintenance. Examples are given of older manufacturing firms adapting facilities to wind turbine component manufacturing. It notes that every 100 MW of installed wind power capacity provides 310 manufacturing sector jobs, 67 contracting and installation jobs, and 9.5 permanent jobs in O & M.

16. Wiser, Ryan, and Mark Bollinger, 2010 Wind Technologies Market Report, U.S. Department of Energy, May 2011.

This report is the latest in a series put out by the U.S. Department of Energy and staff from the national laboratories. It provides a concise summary of the status of the U.S. wind energy industry. Nevada wind installation to date was not listed. The study notes the increasing size of wind turbines with the average size installed in 2010 being 1.79 MW. The proportion of turbine components sourced domestically continues to grow and was an estimated 60% in 2009-10. The capacity-weighted price of wind power sales for projects built in 2010 was $73 per Mwh, though the market remains very fragmented, due to varying state renewable portfolio standards (RPS). This price is expected to fall in the near future due to lower turbine prices. The study also tracks individual wind project costs and reports industry averages. The average cost of projects installed in 2010 was $2,155/kW, and the average cost of proposed projects likely to be built in 2011 is expected to fall. Wind turbine prices have swung sharply from a sellers' market in 2008 to a buyers' market in 2010 due to an overcapacity of U.S. turbine nacelle assembly capability. Turbine prices have fallen 33% or more since late 2008, with an average decline of 20% for orders announced in 2010. O&M costs were observed to rise over time on a given project as components age and need replacement, and capacity-weighted costs of a sample of projects constructed since 2000 was $10/MWh. Wind integration costs into power systems are consistently below 10% and often below 5%. Federal financial incentives have created a favorable and certain policy environment and, combined with lower turbine costs, are expected to cause growth in project construction over the next two years.

Literature on Impacts of High Voltage Transmission Lines

The literature on property values and high voltage transmission lines (HVTL) is more extensive than that for wind energy projects. Two recent articles do a good job of summarizing the findings.

17. Elliott, Peter, and David Wadley, "The Impact of Transmission Lines on Property Values: Coming to Terms with Stigma," *Property Management* (2002) 20 (2): 137-152.

This article does a good job of providing a conceptual framework for analyzing the effects of power lines by focusing on the notion of stigma. They propose three interests at play for this negative externality: health concerns for humans, animals and plants from electromagnetic fields, visual impacts, and noise concerns. They classify the literature into three types of studies:

- Case studies based on regression models;
- Appraisal or valuation-based case studies that use relatively small samples of properties, and
- Case study attitudinal surveys of perceived effects on property values.

The authors review ten regression studies and find negative impacts of 1-9 percent varying with proximity to the power line. Valuation studies are fraught with problems relating to small sample size and the difficulty of matching pairs of property for comparison. Attitudinal studies are generally considered to over-estimate the negative impacts due to the lack of market data and problems with objective presentation of facts to respondents. The authors note that feelings of the stigma associated with power lines can be changed with education. They suggest that communities understand and express more precisely the nature of their dissatisfaction, so that design and engineering changes can address the issues cost-effectively.

18. Pitts, Jennifer M., and Thomas O. Jackson, "Power Lines and Property Values Revisited," The Appraisal Journal, Fall, 2007, pp. 323-325.

This short note provides a useful summary of the literature:

> "When negative impacts are evident, studies report an average discount between 1% and 10% of property value. This diminution in value is attributable to the visual unattractiveness of the lines, potential health hazards, disturbing sounds, and safety concerns. These impacts diminish as distance from the line increases and disappear at a distance of 200 feet from the lines. Where views of the lines and towers are completely unobstructed, negative impacts can extend up to a quarter mile. … Value diminution attributable to tower line proximity is temporary and usually decreases over time, disappearing entirely in 4 to 10 years."

They note that residential lots adjacent to power lines will sell more quickly, but that higher priced homes are more sensitive to proximity. Negative effects on sales time show up more in times of slow property markets. The authors conclude that buyers' personal preferences toward power lines vary and are important to determining whether power lines are a nuisance and negative force on property prices.