REPORT ON THE IMPACT OF SETBACK REQUIREMENTS AND NOISE LIMITATIONS IN WIND ZONES IN MICHIGAN

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David Walters, Electric Utility Industry- Board Chair
Mary Templeton, Public at Large - Board Vice-Chair
Julie Baldwin, Commission Staff - Board Secretary
Steve Brock, Cities and Villages
Robert Ianni, Attorney General
Gene Jorissen, Townships
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Trevor Lauer, Electric Utility Industry
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[1] Transcripts of the public hearings and copies of written comments received are indexed in the Commission's E-Dockets system at MPSC Case No. U-15899.

Analysis and Recommendations

Public Act 295 of 2008 requires the Public Service Commission (Commission) to submit this report to the Legislature on the effect that setback[2] requirements and noise limitations under local zoning or other ordinances may have on wind energy development. The report is to be issued concurrent with the issuance of an order designating wind energy resource zones. This report was developed based on the recommendations of the Wind Energy Resource Zone Board (Board), testimony submitted at public hearings in Lansing, Bad Axe and Traverse City, comments filed by 77 individuals and organizations, as well as the Commission's review of available literature.

In developing its recommendations, the Board estimated wind turbine development in each of four regions based on a 200 meter setback from buildings and structures. It then adjusted these estimates for development reductions based on 300 and 400 meter setbacks, as shown on the following table.

Region	Reduction @ 300 meters	Reduction @ 400 meters
Region 1	33%	59%
Region 2	26%	47%
Region 3	25%	47%
Region 4	34%	61%
Total for all Regions	32%	58%

None of the testimony or comments filed criticized those estimates and the Commission's review of the data indicates that the estimates are reasonable. From these numbers, you can deduce that each 100 meter setback increase can be expected to reduce wind turbine placement

[2] Setback refers to the required minimum horizontal separation between a wind turbine and surrounding structures.

options in a region by 30 percent. In the testimony and comments, there was very little separate discussion about noise limitations as this issue is apparently subsumed by the setback issue.

Although no one took issue with the Board's estimates of setback impact, there was considerable disagreement about appropriate setback distances and who should make setback decisions. A relatively small number of comments are in favor of wind development and they generally support the status quo for establishing setbacks. There is also a small number not in favor of wind development who recommend setback distances be greatly expanded. A larger number of comments are not opposed to wind power development in general, but support significantly greater setback distances because of perceived problems associated with close proximity to wind turbines.

The Commission concludes that these issues should be guided by two fundamental principles. First, setback distances and noise limitation should be determined based on the best available scientific evidence. Second, these matters should be decided at the local level where feasible so that the needs of local citizens can be appropriately considered. No evidence presented to the Commission suggests that a one-size-fits-all approach would work for the entire state.

Accordingly, the Commission recommends that decisions regarding appropriate setback distances and noise levels should remain under the province of local planning and zoning authorities at this time. However, there is a clear need for the dissemination of current scientific information on this issue to decision-makers. The Commission currently supports a Wind Working Group as a component of the Michigan Renewable Energy Program. One purpose of this Group is to provide a forum for the exchange of information. The Commission intends to

expand the role of the Group to include sponsoring periodic meetings to provide needed scientific information to decision-makers.

Purpose of Report

This report is submitted to the Legislature in accordance with 2008 PA 295 (PA 295), Michigan's *Clean, Renewable, and Efficient Energy Act*. Section 147 of PA 295 directs the Commission to provide information on "the effect that setback requirements and noise limitations under local zoning or other ordinances may have on wind energy development in wind energy resource zones." The Commission is further directed to conduct public "hearings in various areas of the state to receive public comment on the report." The Commission is also directed to provide "any recommendations the Commission may have for legislation addressing these issues."

While developing this report, the Commission held public hearings in Lansing, Bad Axe, and Traverse City, and established a public comment period to receive comments. This report includes an analysis of the comments received and the Commission's recommendations to the legislature.

PA 295 Wind Zone Process

PA 295 directs the Commission to create an independent Board and specifies the process for the Commission to designate a primary wind zone and perhaps multiple zones. On December 4, 2008, the Commission issued an Order in Case No. U-15899, creating the Board. As specified in the legislation, 11 members were appointed to the Board: two members representing the electric utility industry, and one member each representing the Commission, alternative electric suppliers, the Attorney General, the renewable energy industry, cities and villages, townships,

independent transmission companies, a statewide environmental organization, and the public at large.

Acting independently of the Commission, the Board studied wind energy production potential in Michigan, the viability of wind as a source of commercial energy generation, and the availability of land for potential utilization by wind energy conversion systems. The Board also conducted modeling and other studies related to wind energy, including studying existing wind energy conversion systems, estimates for additional wind energy conversion system development, and average annual recorded wind velocity levels. The Board's studies included an examination of wind energy conversion system requests currently in the Midwest Independent System Operator interconnection queue. Based on these analyses, the Board issued a proposed report detailing its findings based on the modeling and studies.

The Board's proposed report included four major elements. The first was a list of the Michigan regions with the greatest wind resource potential, deemed by the Board to be potential wind energy development regions. The second was an estimate of the minimum and maximum installable wind generating capacity within each region. Third, was an estimate of the minimum and maximum annual wind energy production potential within each region. The fourth element was an estimate of the currently installed capacity in each region.

The Board submitted a copy of the proposed report to the legislative bodies of each local unit of government located within the wind regions. After the legislative bodies had an opportunity to submit comments, the Board held two public hearings on the proposed report, one in Bad Axe and the other in Scottville. At the Bad Axe hearing, 30 people provided oral comments. Fifteen people provided comments at the Scottville hearing. Seventy-seven written

comments were also submitted. In addition, two petitions were delivered to the Board, signed by a total of 119 Thumb-area residents.

On October 15, 2009, the Board issued its final report. On November 30, 2009, affiliated transmission companies and independent transmission companies with transmission facilities in the vicinity of identified wind regions submitted documents to the docket identifying transmission infrastructure needed to support wind energy production potential for each of the deemed regions. In accordance with the requirements of PA 295, the Board dissolved in January, 90 days after the issuance of its final report.

On January 27, 2010, the Commission will issue its Final Order in Case No. U-15899. Concurrent with that Order, the Commission submits this report to the Legislature, on the effect that setback requirements and noise limitations under local zoning or other ordinances may have on wind energy development in wind zones. In future years, on or before the first Monday of March of each year, the Commission will submit an annual report to the Governor and the Legislature, summarizing the impact of establishing wind zones, expedited transmission line siting applications, estimates for future wind capacity within wind zones, and providing recommendations, if any, for positive program changes.

Prior to issuing this report, the Commission held public hearings in three Michigan cities; Lansing, Bad Axe, and Traverse City. The three hearings were held simultaneously, using teleconference and Web conference capability between Lansing and the two satellite locations, so that attendance and participation would be facilitated for all interested parties. Twenty people testified at the hearing in Bad Axe and 21 in Lansing. Although 10 people attended the hearing in Traverse City, none of them provided oral testimony.[3]

[3] Copies of sign-in sheets from each location and the hearings transcript are posted on the MPSC Web site, along with all the other docket files, at MPSC Case No. U-15899.

Seventy-eight written comments were received from 70 individual respondents. Several of these were also read into the hearing record by the same individuals, who provided both oral testimony and a written set of their comments. Twelve of the commenters represented interested organizations, including municipalities, utilities, wind farm developers and financiers, and a law firm. The remaining 66 responses were from the public at large, with the majority identifying themselves as residents (or former residents) of Huron Country.

As previously discussed, none of the comments took issue with the estimates of setback impacts developed by the Board. The Commission has reviewed those setback impact estimates and concludes that they are reasonable. Although there was no disagreement about the setback impacts, there was considerable disagreement about the process for determining setbacks. The Commission is addressing these by expanding the role of the Wind Working Group, as previously discussed.

In addition to addressing the issues directly relevant to this report, comments were filed on a variety of important but tangential matters, including: (1) health and safety, (2) setback distances, (3) shadow flicker, (4) effects on real estate and property values, (5) economic development, (6) effects on wildlife, and (7) state versus local control.

Other Comments on Issues

Health and Safety: Forty-one comments were received regarding concerns that wind turbines and wind farms might have effects on the health and safety of adjacent land owners. Three comments were generally positive, in favor of increased wind development and citing the belief that wind energy has fewer negative health and safety effects compared to other energy sources. Thirteen comments generally recommended changes in Michigan wind farm development policies. Such proposals range from requiring greater setback distances from

turbines, to disallowing development of wind turbines in farming communities or near houses. Some commenters propose complete moratoria on any wind development in their communities.

Several comments requested additional research on potentially adverse health effects alleged to occur due to proximity to wind turbines. Some commenters recommended that health studies be completed and moratoria be put in place until the studies are complete. There were general comments recommending greater setback distances for new installations, with the intended goal of minimizing negative health and safety impacts. Several residents living in potential wind zone regions specifically expressed concerns about negative health effects they believe will be associated with commercial scale wind turbines, due to low-frequency sound and infra-sound.

A few other commenters countered the health and safety setback comments made by others. Some state that the residents who have noise and other setback concerns are, by and large, those who are not happy with compensation from the wind development companies. There were also comments from one resident who lives within 1,000 feet of a wind farm and another who lives within 1,700 feet of three wind turbines. These residents report no complaints of noise or other complications with their proximity to the wind turbines.

Setback Distances: Approximately 40 comments were submitted regarding setback distances. About three-quarters of the comments are in favor of greater setbacks for wind turbines. These commenters believe greater setbacks are necessary to protect the health and safety of citizens. A professional consultant engineer, who states he has worked with companies regarding problems related to noise, vibration and acoustics and is from MAS Research Ltd., based in the United Kingdom, claims that proposed setbacks of 1000 feet in Michigan would, because of noise, represent intolerable levels for many members of the community. Numerous

individuals also recommended various setback distances based on what they have heard and felt from their own experiences. One commenter, who states he is an acoustical engineer, believes based on his research, that industrial scale turbines should not be placed within a 1.25 mile distance of residential properties. Numerous comments include reports of setback recommendations from other states and countries. Several comments also reference a 2009 book, *Wind Turbine Syndrome*, written and self-published by Nina Pierpont, M.D. Other comments refute Pierpont's book.

Comments were submitted by RES Americas, Wind Capital Group, John Deere Renewables, Wind on the Wires and NextEra Energy Resources recommending that setback requirements be based on sound science.

Shadow Flicker: Approximately 15 comments were on the topic of wind turbine shadow flicker. According to Wind Engineers, Inc., shadow flicker is defined as alternating changes in light intensity caused by the moving wind generator blades casting shadows on stationary objects, such as a wall at a dwelling. Such shadows occur when the rising or setting sun is directly aligned with an individual wind turbine and a particular receptor area nearby. Key factors that determine the potential for shadow flicker are the spatial relationships between a wind turbine and a receptor, as well as wind direction. No shadow flicker will occur when the sun is obscured by clouds or fog or when the turbine is not rotating. This phenomenon is well understood by wind farm designers, and careful placement of individual wind machines vis-a-vis houses and other buildings can minimize shadow flicker.

A number of residents in Ubly reported feeling nauseated and experiencing headaches as a result of the shadow flicker from a nearby turbine, causing them to relocate on numerous occasions for the duration of shadow-flicker occurrences. A couple in Pigeon who live near the

Harvest Wind Farm have not experienced any negative health effects from living near a wind farm and described the shadow flickering as minimal. According to Next Era Energy Resources, shadow-flicker should be modeled and limited to 30-40 hours per year per exposed household. Next Era reports: "Shadow-flicker, if it is an annoyance, can be eliminated or at least largely ameliorated by landscaping, or through the use of window shades, blinds, or curtains."

Real Estate, Property Values, and Farmland Preservation: Eighteen comments were received regarding potential affects of wind farm proximity on real estate values. All but one of the comments addressed wind farm development negatively. Negative comments compared wind farm development effects on property values with commercial and industrial development and the claimed negative effects those types of development might have on rural, residential real estate values. One commenter stated that potential real estate buyers in the area of the proposed farms are awaiting confirmation of wind development plans before purchasing in the area. Others want assurances that the wind developer or utility company will give them the undepreciated fair market value for their homes, if and when they decide to sell. Many of the comments referred to studies done on the detrimental impact of wind farms on real estate values, but none contained direct references.

A Lawrence Berkeley National Laboratories (LBL) report issued December 2, 2009, investigates the effects of proximity to and views of wind farms on real estate values.[4] This study employs eight different hedonic regression models,[5] as well as a repeat sales and sales volume analysis from which it draws and market data from approximately 7,500 real estate

[4] *The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis*, Lawrence Berkeley National Laboratory. Hoen, Ben, Wiser, Ryan, Cappers, Peter, Thayer, Mark, and Sethi, Guatam. (2009, December).

[5] The hedonic regression model analyzes each property's component parts (i.e. bedrooms, bathrooms, location, land area, etc.), and values each piece separately, to estimate the marginal contribution to the value of the site as compared to other similar sites. It is widely used for tax assessment, academic studies, and other compiled property appraisal projects.

transactions in the vicinity of 24 wind farms scattered over nine states. The homes were located from 800 feet to over five miles from the nearest turbine and the transactions analyzed took place at any point from more than as much as two years prior to the announcement of the planned wind facilities to more than four years after their construction. Each of the homes that sold, and were used in this study was personally visited by at least one of the LBL researchers, to determine the extent of the view of the nearby wind farm. This peer reviewed report is believed to be the most comprehensive to date on the subject of the effect in the United States of wind farm proximity on real estate value. It reviews over 20 previously published reports, and points out some of the weaknesses of previous literature on the subject. For example, many previous studies used surveys of homeowners or real estate agents, rather than actual market prices. Some relied on simple statistics that can be influenced by small numbers of sales transactions or survey responses. Most of the studies used data from only a small geographic area and did not report on tests of statistical significance, making it hard to distinguish between meaningful results and statistical anomalies.

The LBL report reaches this conclusion:

> Based on the data sample and analysis presented here, 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 of the home to those facilities. Although the analysis cannot dismiss the possibility that individual homes or small numbers of homes have been or could be negatively impacted, it finds that if these impacts do exist, they are either too small and/or too infrequent to result in any widespread, statistically observable impact. Moreover, to the degree that homes and wind facilities in this sample are similar to homes and facilities in other areas where wind development is occurring, the results presented here are expected to be transferable.[6]

[6] *See, The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis*, p. 75.

Economic Development: Six comments were submitted regarding economic development and job creation. Wind Capital Group and John Deere Renewables believe wind turbines will create jobs, boost the local economy and tax base, along with providing a new source of revenue to farmers and ranchers who lease land for wind development. Comments were also filed by those who believe economic development effects due to wind energy development are minimal, that the jobs created are temporary, and will be filled by itinerant workers, who will vacate the area once construction is completed. In an indirect way, one commenter believes that the turbines will wreck tourism in their area, which would then result in their local economy declining.

On January 4, 2010, the Michigan Climate Action Council released its report[7] of the macroeconomic impacts of its action plan on the state's economy. Among other things, the action plan found that wind generation developed through a renewable portfolio standard would reduce greenhouse gas emissions by 3.7 million metric tons of carbon dioxide equivalent by 2015 and by 10.3 million metric tons of carbon dioxide equivalent by 2025 at a cost of $47.31 per ton.

The National Renewable Energy Laboratory (NREL) has conducted an analysis of the economic impacts of wind generation compared to alternatives in three states, including Michigan.[8] The NREL report concluded:

> Results in all three states show that adding wind facilities will provide a greater economic benefit to the state economy, due in large part to payments for property taxes. Wind pays a proportionately larger share in property taxes because more facilities must be erected to generate equivalent power.

[7] *Macroeconomic Analysis: Michigan Climate Action Plan Final Report Summary,* Center for Climate Strategies.
[8] *Comparing Statewide Economic Impacts of New Generation from Wind, Coal, and Natural Gas in Arizona, Colorado, and Michigan.* National Renewable Energy Laboratory Technical Report NREL/TP-500-37720, May 2006.

Specifically, the NREL found that in Michigan wind generation capable of producing two billion kilowatt-hours annually would produce economic benefits of approximately $900 million, compared to benefits of less than $500 million for a coal or natural gas plant. Almost half of the benefits are derived from local property taxes and about one-third come from wages paid during construction.

A summary of other economic development studies is provided in *Appendix A.*

Effects on Wildlife: Six comments were received regarding the potential affects wind turbines and wind farms might have on Michigan wildlife. One favors increased wind development and five recommend changing the location of the wind development or changing the renewable energy technology altogether.

Special concerns also have been raised regarding avian and bat mortality. Experience with wind farms elsewhere around the world strongly suggests that avian and bat casualties can be greatly reduced when wind farm siting and wind generator micro-siting is conducted with careful attention to migration patterns, surrounding habitats, and wind turbine operating characteristics.

The Commission is not aware of any studies that suggest that well planned and operated wind farms are likely to be particularly harmful to any of Michigan's flora and fauna. In fact, several of the country's most important wildlife protection organizations have already issued policy statements supporting appropriately planned wind farms.[9] Furthermore, ever since the casualties of significant numbers of charismatic raptor species at California wind farms were widely reported in the mid-1980s, wind turbine manufacturers have made concerted efforts to redesign towers and generators to minimize casualties, and wind farm developers have similarly

[9] *See,* for example, *Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document*, National Wind Coordinating Committee (2009), and *Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines*, U.S. Fish and Wildlife Service (2009).

learned how best to avoid, negative impacts on wildlife. These efforts continue, as new research provides additional data and identifies management practices that can ameliorate problems.[10]

State and Local Control: More than two dozen of the comments submitted discuss the issue of whether wind energy siting and zoning is best addressed at the state or local government level, or what the role of state and local governments should be. In general, there is divergence of opinion about whether, or the extent to which, decision making authority for wind siting and zoning should be maintained at the local level, which is the present practice in Michigan.

Some comments recommend that the Commission act as an advisor to provide responsible recommendations or guidelines to local units of government. Some believe the state should set minimum setback standards, but recommend allowing local governments to exceed them. Others are inclined to put more trust in the state government to provide suitable siting and zoning, and believe that fairness and consistency necessitates having statewide standards. They are concerned that local zoning authorities may be too easily influenced to give too much deference to developers' needs as opposed to residents' needs. Some are also concerned that chaos could result and wind resource development could effectively be blocked by patchwork implementation of widely varying local standards.

Other comments indicate a belief that local governments must retain their established jurisdiction for determining setbacks, height limits, and noise regulations. They stress the ability to involve local residents in planning at the grassroots level. They also note that, due to the diversity of the state, it is important that local leaders and planners take into account their

[10] Western Michigan University is currently conducting a study concerning the impact of wind power on bats with the help of a $100,000 U.S. DOE grant, and the Michigan State University Extension's Michigan Natural Features Inventory (MNFI) was awarded a DOE grant to study the migratory patterns of bats and birds along the Lake Michigan shoreline.

specific population and geography when developing strategies and identifying areas appropriate for wind turbines.

RES Americas states that local government is crucial in efforts to create a balance between viable economic environment and the comfort and safety of those who live near a wind energy project. RES states that it has been associated with over 14 percent of all installed wind capacity in the country and it believes that local government has contributed to this success.

A township supervisor from Huron County would not like to see the state assume total control over wind energy; the townships should be able to govern themselves. He indicates the county and its townships have used a collaborative approach that has been useful in the creation of their renewable energy program.

Conclusion

At this time, the Commission recommends that decisions regarding appropriate setback distances and noise levels should remain under the province of local planning and zoning authorities. However, the Commission observes a clear need for the dissemination of current scientific information on this issue to decision-makers. The Commission intends to expand the role of the Wind Working Group to include sponsoring periodic meetings to provide the needed information.

Appendix A

Summary of Recent Economic and Employment Impact Studies for Michigan Energy Policy Analysis

Study author(s), year, publishing organization	Synopsis: scope, major findings
Miller, Wie, and Rose, 2010, Michigan State University, Center for Economic Analysis.	Uses REMI[1] modeling to analyze economic and employment impacts of various measures included in Michigan Climate Action Council recommendations. Analysis includes estimates of impacts based on modeling the state's Renewable Portfolio Standard of 25% by 2025 and a Distributed Generation "Carve-Out" policy. Estimates this policy can be used to reduce greenhouse gas emissions by 12.88 million tons of carbon dioxide equivalent by 2025, at an average cost of $41.14 per ton. Estimates between 2,000 and 6,000 added Michigan jobs associated with this measure, by 2025, and a positive net present value impact on the state's economy of $1.4 billion.
U.S. Department of Energy, 2008.	Analyzes a scenario where 20% of U.S. electricity needs would be provided by wind energy by 2030. Appendix C covers *Wind Related Jobs and Economic Development*. Explores economic and employment impacts in wind energy manufacturing, construction, and operations, with some data presented by region. Expects Michigan would be one of eight states with more than 10,000 MW of installed wind capacity by 2030. Concludes Michigan is one of four states slated to gain more than 30,000 manufacturing jobs by 2030.
Edison, Elliott, Fischlowitz-Roberts et al., 2007, University of Michigan, Center for Sustainable Systems	REMI modeling of Michigan economy, primarily for greenhouse gas emissions reductions. Michigan RPS (10% by 2015 and 20% by 2025), plus stronger appliance and building energy efficiency standards. Modeling to reflect analysis in 21CEP. Average annual gain in gross state product: $156.9 million. Average annual gain in employment (job-years): 1,962.
Laitner and Kushler, 2007, American Council for an Energy Efficient Economy	Uses IMPLAN[2] data for Michigan and modeling based on proposals presented in Michigan's 21st Century Electric Energy Plan. When compared from 2008–2023 to a 'business-as-usual' plan involving traditional utility power plants, benefits of a portfolio incorporating energy efficiency and renewable resources include: net cumulative savings of $2.6 billion or more; net annual employment increase between 3,900 and 10,000 jobs; and a reduction of air emissions from conventional power plants of 15-28%. The large range in outcomes results from modeling both the recommended scenario from Michigan's 21st Century Electric Energy Plan and also roughly double the Plan's proposed energy efficiency program.
Madsen, Telleen-Lawton and Shriberg, 2007, Environment Michigan Research and Policy Center	REMI modeling of Michigan reflects a 25% RPS by 2025 plus $225 million annual energy efficiency program spending. Results show cumulative Michigan energy cost savings of $2.2 billion through 2020; $3.3 billion in increased wages; and 88,000 person-years of new Michigan employment through 2020 (about 7,000 jobs).
Polich, Amlin, Levesque et al., 2007, Michigan Department of Environmental Quality and NextEnergy Center	REMI modeling of Michigan to reflect analysis in the state's 21st Century Electric Energy Plan. Modeled 7% RPS by 2016 or 15% by 2025. Findings show: $750 million to $1.1 billion gain in gross state product (GSP); $415 to $664 million increase in disposable income. RPS alone would achieve $200-$500 million gain in GSP, but minus $229 to $100 million in real disposable income (0.006% to 0.002%), due to higher projected electricity costs. The RPS alone would net the state 2,000 to 6,400 jobs, compared to 11,000 to 17,000 jobs if combined with energy efficiency.

Study author(s), year, publishing organization	Synopsis: scope, major findings
Union_of_Concerned_Scientists, 2007	Analyzes Michigan impacts from national RPS of 20% by 2020. Concludes Michigan will gain: $818 million new capital investment; $377 million income to rural landowners; $24 million local tax revenues; $160 million lower electric and gas utility bills; and net 3,540 jobs. Estimates Michigan would rank 7th in the U.S. for renewable energy manufacturing, with 1,625 Michigan jobs.
Sterzinger and Stevens, 2006, Renewable Energy Policy Project	Analyzes adding 18,500 MW of new renewable energy in the U.S. each year for 10 consecutive years, in order to create one global climate change stabilization wedge.[3] Assesses component parts of renewable electric generating technologies (biomass, geothermal, solar, and wind), and then analyzes manufacturers of each component, by NAICS code[4] and market share data, to assign national demand to states and then counties. Concludes Michigan ranks 9th in the U.S. for renewable energy jobs gains and 7th for potential investment. Finds Michigan currently has >2,000 firms in the relevant NAICS sectors. Estimates 34,777 Michigan jobs would be created, with $5.3 billion invested in manufacturing components.
Tegen, 2006, National Renewable Energy Laboratory and Wind Powering America	Compares a new 250 MW, 80% capacity factor coal plant to 715 MW of wind generation with 28% capacity factor, for economic and employment impacts for Michigan. Uses the jobs and economic development impacts (JEDI) model.[5] Finds over 20 years, wind energy generates twice the economic and employment impacts as coal, not counting wind equipment manufacturing jobs. Wind scores slightly higher than coal during construction, but generates more O&M jobs.
Kammen, Kapadia and Fripp, 2004, Renewable and Appropriate Technology Laboratory, University of California, Berkeley	Reviewed 13 other studies from 1999 to 2004. Completed U.S. economy-wide analysis of a 20% RPS by 2020. Major finding: "Expanding the use of renewable energy is not only good for our energy self-sufficiency and the environment; it also has a significant positive impact on employment" (p. 1). Renewable energy, modeled in three scenarios and compared to two fossil fuel scenarios, creates 1.9 to 2.1 times more life-cycle jobs.
Union_of_Concerned_Scientists, 2004	Analyzes Michigan impacts from a national RPS of 20% by 2020, using 2004 EIA NEMS[6] model with UCS renewable energy assumptions. Benefits to Michigan of the added renewable energy include: $1.2 billion in new capital investment; $429 million in income to farmers and rural landowners; $83 million in new local tax revenues; $1.7 billion in lower electricity and natural gas bills; and 4,950 new jobs. Expects renewable energy produces 2.3 times as many jobs as fossil fuels.
Hewings, Yanai, Learner et al., 2001, Environmental Law and Policy Center	Modeled a 20-year implementation strategy including performance targets for efficiency (17% demand reduction by 2010; 28% by 2020) and renewables (8% by 2010; 22% by 2020). Covered ten Midwestern states, including Michigan. Michigan findings include: Energy efficiency modeled brings $1.3 billion increased annual economic output and 16,100 new jobs by 2010. By 2020, $2.4 billion annual economic output and 29,100 new jobs. Renewable energy modeled brings $400 million and 4,100 new jobs by 2010 and $1 billion and 9,100 new jobs by 2020.

Study author(s), year, publishing organization	Synopsis: scope, major findings

[1] REMI is Regional Economic Models, Inc.

[2] IMPLAN® is economic impact modeling system software developed by Minnesota IMPLAN Group, Inc.

[3] The concept of global climate change stabilization wedges was introduced by Pacala and Socolow, 2004. See http://www.princeton.edu/wedges.

[4] NAICS is the North American Industrial Classification System, used by the U.S., Canada, and Mexico. NAICS codes replace the Standard Industrial Classification (SIC) System that had been used in the U.S. since the 1930s. *See*, http://www.census.gov/naics and http://www.census.gov/epcd/www/asambler.htm.

[5] *See*, http://www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707.

[6] NEMS is the National Energy Modeling System (NEMS), from the Energy Information Administration, U.S. Department of Energy ([EIA], 2003). Many of the data files that comprise NEMS are updated annually. *See*, http://tonto.eia.doe.gov/reports/reports_kindD.asp?type=model%20documentation.

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See also:
Catalog of the Leading Sources of Information on Job Growth Opportunities in the New Energy Economy.