

Projected Impacts of Renewable Portfolio Standards on Wind Industry Development in Michigan

**White Paper Prepared for the Office of the Governor
State of Michigan**

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Projected Impacts of Renewable Portfolio Standards on Wind Industry Development in Michigan

Summary

The adoption of Renewable Portfolio Standards (RPS) is arguably the major precursor to renewable energy development at the state level. In the case of Michigan, Governor Jennifer Granholm's 21st Century Electric Energy Plan proposes the adoption of such legislation as the basic framework for setting the stage for and spurring the development of renewable energy in the State. In response to the Governor's plan, the Michigan legislature is currently considering a number of RPS proposals. Much of the debate has centered on the provisions of the RPS adopted, including the percentage RPS to be achieved, the timeframe for such achievement, and the mandatory or voluntary nature of such provisions.

There is generally little disagreement about whether or not RPS plays a critical role in the development of the renewable energy industry. Several studies have estimated the potential payoffs of RPS in Michigan and beyond. There is, however, much less agreement about how much impact RPS would have and about the specific roles of the various provisions of an RPS legislation. These issues are critical to Michigan, especially now when the provisions of pending legislation are still to be settled.

The objective of this study is to estimate the impacts of RPS adoption on the State of Michigan. Centering on wind industry development, this study projects installed wind capacity and predicts the impact on investment, employment, earnings, and lease payments to land owners. Impacts on state and local tax revenues are excluded due to the fact that the future taxation of wind installation is yet to be settled. The analysis is based on a 50-state model of wind installations by RPS adopters and non-adopters. It is estimated that RPS adoption is a major driver of installed wind capacity in the United States. States with RPS are shown to have markedly higher wind installation rates than states without RPS.

Based on the model, the following impacts of wind industry development are projected for Michigan, the majority of which are attributable to the adoption of RPS:

- Approximately 780 megawatts (MW) per year in added installed wind capacity in the foreseeable future.
- Under specific assumptions, Michigan will reach 16,000 MW of deployed capacity by 2029.

Based on state level economic multiplier information available through the JEDI model, the following economic impacts associated with wind capacity deployed as a result of RPS adoption are projected:

- Approximately 1,100 construction jobs per year for the next two decades.
- Approximately 318 recurring or permanent jobs related to the management and maintenance of wind installations by 2010.
- Approximately 3010 recurring or permanent jobs related to the management and maintenance of wind installations by 2029.
- Approximately \$1.25 billion per year in construction related new investments and spending over the next two decades or so.
- Approximately \$464 million in recurrent spending in maintenance and management by 2010 and \$4.4 billion by 2029.
- Approximately \$21 million per year in new construction wages for the next decade or so.
- Approximately \$7.6 million in permanent annual wages by 2010 and \$96 million by 2029. These earnings will be concentrated on the coastal areas of Michigan.
- Approximately \$4.8 million in lease payments to landowners per year by 2010 and \$47 million per year by 2029. These earnings will be concentrated on the coastal areas of Michigan and represent a major boost in the economic plight of such landowners, the vast majority of whom will be farmers.

The above estimates do not include the following:

- Secondary employment, wage and spending impacts related to current and potential wind component manufacturing in Michigan.
- Impacts of RPS on property taxes paid to local units of government nor business or income taxes paid to the state government. These tax impacts depend, to some extent, on how the various components of wind energy installations are classified for property tax purposes.¹
- Impacts on Michigan if Michigan's manufacturing capacity were to be deployed toward the

¹Since installed wind systems will likely be installed on land leased from farmers and other landowners, there is currently lack of clarity about whether or not wind related assets will be viewed as real property or personal property. Roads, fences and foundations might be considered improvements, while the turbines themselves might be considered the property of the tenant developer/operator which might or might not be considered non-land owner business property. The Office of the State Treasurer (Commercial/Industrial/Utilities Valuation Section) is currently evaluating this issue, with an ultimate decision possible in the near future. At that time this report can be revised.

production of wind turbines and components.²

- The possibility that Michigan component manufacturers can supply wind systems to other states in the region, and possibly for export outside of the region.³

To the extent to which Michigan's manufacturing capacity could be brought to bear on wind components manufacturing, Michigan could capture a large percentage of the total spending on wind components by developers. For example, some \$1.25 billion per year of the construction investment and spending dollars and \$4.4 billion per year in recurrent spending could be internalized in Michigan by 2029. In other words, the employment and income impact of manufacturing wind components in Michigan for installations in Michigan could be huge, perhaps as high as \$6 billion a year if secondary impacts are included. Given Michigan's recent history of manufacturing job loss and heightened interest in new opportunities, wind appears to be an interesting option.

Given these projected impacts, State policy makers must carefully balance the benefits against the concerns of opponents to RPS. However, it is clear that without strong RPS legislation, it will be difficult for Michigan to develop its wind capacity and pursue energy sustainability. We offer no other policy recommendations than the adoption of a good RPS legislation. Since the major features of RPS legislation related to accelerating wind installation (target date and percentage goal) are important, the legislature must balance the expected benefits and costs, including increased energy independence, Michigan industrial development, effects on farmers and other landowners, the environment, recreation and tourism, and the impacts on utility companies and alternative electricity suppliers and ratepayers.

² Significant effort is being devoted to strengthening Michigan's role in the industrial production of wind components.

³ Given the wind resource in the Great Lakes and Great Plains states, to which large components could easily be deployed, a strategic wind industry development program could be an important component of a viable economic development strategy for Michigan.

Projected Impacts of Renewable Portfolio Standards on Wind Industry Development in Michigan

Background

A Renewable Portfolio Standard (RPS) is a policy that mandates that a percentage or designated amount of electricity supplied by utilities be from renewable sources such as wind, solar, hydro, waves, water currents, and biomass. More states are adopting such policies in response to volatile and rising fuel costs; long-term risks associated with traditional energy sources; growing national security, human health, and environmental concerns; and interests in long-term energy sustainability.⁴ Anecdotal evidence suggests that RPS is a powerful tool for mobilizing the renewable energy sector and enhancing related economic opportunities. However, reliable science-based information on the impact of RPS adoption on renewable energy development is limited, especially information that can predict the effects of RPS adoption on economic development.

Governor Jennifer Granholm's 21st Century Electric Energy Plan sets forth an RPS goal for the State of Michigan.^{5,6} As a result, both houses of the Michigan legislature are currently considering RPS legislation. Critical to the State's decision making process is information on the potential energy and economic impacts of any adopted legislation. Since the proposed bills have varying provisions, including target date, target percentage of renewable energy, generation disclosure requirements, mandatory green power offering, and whether or not the standards are voluntary or regulatory, the impacts on renewable energy industry development and on the economy are likely to depend on the stringency of these provisions. To date, no acceptable study exists which documents the economic impacts of specific components of adopted RPS legislation. Clearly, none exists that is applicable to Michigan.

This briefing report is one among a series from the Hannah Professor Research Program of the Land Policy Institute on renewable energy policy. It is designed to inform policy makers involved in the RPS adoption process. This particular report focuses on predicting the economic and industry development impacts of RPS adoption on wind energy deployment. The prediction is based on an econometric model that estimates the relationships between installed wind capacity and its hypothesized drivers, including RPS adoption, using cross section data from all fifty (50) US states. Installed wind capacity for Michigan is projected through the year 2030, based on the RPS features inherent in the Governor's 21st Century Electric Energy Plan and other structural, legislative, and energy policy characteristics of the state. The economic impacts of projected wind tower installations (spending, wages, lease payments, and employment created) are further delineated by using the coefficients of investments, wages,

⁴ As of September 2007, RPS laws and rules have been implemented in 26 states and the District of Columbia, and an additional three states have adopted RPS goals. See

http://www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707.

⁵ State of Michigan, *Executive Directive No. 2006-2, 21st Century Energy Plan*, Lansing, MI, 2006.

⁶ Lark, J. P. (Chair, Michigan Public Service Commission). *Michigan's 21st Century Electric Energy Plan*, 2007.

jobs, and land leases from the JEDI II Model developed by the National Renewable Energy Laboratory (NREL) of the US Department of Energy.^{7,8} The results suggest significant impact of RPS on the development of the wind industry and on the economy of Michigan, depending on the State's economy, policies, and the nature of the provisions of adopted legislation.

Methodology

To be able to forecast installed wind capacity, a wind capacity determination model must first be estimated. In the US, some 26 of the 50 states have already adopted RPS legislation. The correlation between such legislation and wind industry development seems very obvious. However, considering the importance of RPS legislation and its potential to generate employment and economic activity, the State of Michigan needs to know, more precisely, what returns the investment of political capital expended on RPS legislation is likely to yield. This is particularly important at this time, when Michigan's economy is facing major challenges.

Many studies have focused on RPS adoption in the US and other parts of the world. For example, a study published this month in *Energy Policy* by Huang et al. investigated the factors that led to the adoption of or intention to adopt RPS across all 50 US states.⁹ The study postulated that Gross State Product (GSP), growth rate of population (GRP), political party dominance, education level, natural resources expenditure, and share of coal in electricity generation were drivers of legislative adoption. The findings suggested that public education (knowledge), followed by political party dominance, GSP and GRP, have large impacts on the probability of RPS adoption. The study, however, did not look at the impact of RPS following adoption, or the differential impacts of adoption on the pattern of wind industry development in the US. However, it offered some useful insights, such as the importance of considering such factors as political party dominance, state economic size (GSP), and state population growth (GRP).

We are aware of only one study that has examined the impacts of RPS on wind industry development in the US. The study published by Menz and Vachon, also in *Energy Policy*, analyzed the contribution to wind power development of several state-level policies, including RPS, fuel generation disclosure rules, mandatory green power options, public benefits funds, and electricity retail choice facilitated by electricity restructuring. The findings support existing anecdotal and case study findings that RPS positively impacts installed wind capacity.¹⁰

⁷ National Renewable Energy Laboratory (NREL), "Jobs and Economic Development Impact (JEDI) Model: A User Friendly Tool to Calculate Economic Impacts From Wind Projects", Golden CO, March 2004.

⁸ Tegen, S., Goldberg, M., Milligan, M. (June 2006). "JEDI II: Jobs and Economic Development Impacts from Coal, Natural Gas, and Wind Power (PDF 499 KB)." Presented at WINDPOWER 2006, June 4-7, 2006, Pittsburgh, PA. NREL/PO-500-39908. See

http://www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707.

⁹ Huang, Ming-Yuan, Janaki R.R. Alavalapati, Douglas R. Carter and Matthew H. Langholtz, "Is the choice of renewable portfolio standards random?" *Energy Policy*, Volume 35, Issue 11, November 2007: 5571-5575.

¹⁰ Menz, Fredrick C and Stephan Vachon. 2005, "The Effectiveness of Different Policy Regimes for Promoting Wind Power: Experiences from the States." *Energy Policy*, Volume 34, Issue 14, September 2006: 1786-1796.

The Menz and Vachon study is closely related to the goal of this study. It established a direct relationship between RPS adoption and installed wind capacity. The Menz and Vachon study, however, had some methodological flaws which make it an inappropriate tool in projecting the future wind industry development effects of RPS adoption in Michigan. First, unlike Huang et al., it ignored the roles of state economic and political conditions. If such factors impact adoption of RPS, they are expected to also impact the pattern of deployment of wind energy, since the strength of the RPS adopted should be a key factor in post-RPS wind industry development. Second, it accounted for RPS independently as a variable without specifically decomposing it to account for the differential effects of various state's RPS provisions. A more appropriate approach is to decompose installed wind energy capacity while accounting for all causal factors, including the adoption of RPS, but also decomposing RPS impacts into the impacts related to each major RPS provision.¹¹ The Menz and Vachon study, however, provides useful information on how to model the impact of RPS adoption on wind industry development and the types of variables to include in our analysis.

In this study, the wind capacity installation determination model is first used to econometrically estimate the impacts of RPS adoption on wind industry development. The analysis is based on a 50-state model of wind installations by RPS adopters and non-adopters. The parameters estimated by the model are then used to project the installations of wind turbines in the state through the year 2030. Finally, the projected installations of wind turbines are used to generate estimates of economic impacts.

In the US, significant differences exist across states in both potential and installed wind capacity. Significant differences also exist in their wind energy potential, renewable energy policies, socio-economic characteristics, and energy business climates. There are also differences in the nature of RPS adopted in those states that have adopted such legislation. The approach used in this study is to model Installed Wind Capacity (WINDCAP) as a dependent variable regressed against hypothesized determinants (drivers). Data on installed wind capacity (WINDCAP) and anticipated drivers from all 50 states of the US are used in modeling the effects of the determinants of wind capacity installation, including the adoption of RPS legislation. The details of the wind determination model (specification, estimation and estimates) are provided below.

Identifying the Drivers of Installed Wind Capacity

The hypothesized determinants of installed wind capacity include the following classes of variables:

- Wind Potential -- Obviously, a state's wind potential (WINDPOTEN) would impact positively on its deployed capacity, with or without RPS. The more available wind resources a state has, the more likely developers will target the state and successfully complete wind energy installations.¹²

¹¹ Since the impact of RPS adoption occurs only because of its provisions, the ideal framework is to estimate the impact of RPS provisions subject to the adoption of legislation.

¹² In Michigan, the ratio of installed capacity to total wind resource is very small (<1%), presumably due, at least in part, to the absence of RPS legislation.

- Renewable Energy Policy -- States differ in their renewable energy policies and in the nature of the Renewable Portfolio Standards they adopt. Renewable energy policies would typically include RPS adoption itself (RPS), legislative adoption of a public benefit fund (PBF), the prior existence of a systems benefit charge (SYSBEN), the existence of required green power option (GREEN), and the existence of state generation disclosure rules (DISCLOSE). These variables needed to be considered as factors independent of RPS adoption.
- RPS Stringency Factors -- In recognition of the differences in the stringency of RPS standards across states, the following factors were accounted for: (1) the time frame between the date of adoption and the target year, or years to target (TARGETYR), (2) time since RPS was adopted (SINCERPS), (3) the proportion of state energy supply that is mandated to be renewable (RPS%), and (4) whether the RPS mandate is voluntary or regulatory (REG).¹³ These characteristics of RPS would help estimate the effect of each element of an RPS legislation on wind capacity installation.
- State Demographic Characteristics -- States in the US differ demographically and structurally. In the case of wind development and RPS, following preliminary regression and correlation analysis, the most relevant state demographic variables were determined to be state population density (POPDEN) and percentage of state population that is urban (URBAN%). These capture the degree of urbanization, consumer concentration, industrial agglomeration, growth potential in energy demand, and other industrial as well as consumer characteristics.¹⁴
- State Economic Conditions -- A state's economic and financial situation is expected to affect not only public policy choices that impact on industry and consumers, but also the outcomes of such choices. Measures of a state's economic performance, debt structure, and tax structure can be used as proxies for economic and financial conditions. Gross State Product (GSP), outstanding short and long-term debt of a state (DEBT) and a state's ability to tax (TAX) were determined to be the most relevant factors. These state economic characteristics would help estimate the effect of overall economic conditions on wind energy development. Consistent with the findings of Huang et al., GSP is expected to be directly related to the demand for alternative energy, i.e., states with higher GSP levels are expected to demand more renewable energy. On the other hand, the DEBT is expected to be inversely related to interest in alternative energy development since states in debt are expected to be more focused on their economic challenges. A state's ability to tax, measured by the state's tax per capita (TAX), is expected to be positively related to renewable energy development as ability to tax indicates the potential to raise required resources to finance major public programs. As such, a state's ability to tax is expected to be positively related to interest

¹³ The RPS-required new renewable energy per year was considered as an independent variable. Due to the difficulty of obtaining such data and the fact that comprehensive use of this information is likely to reduce the degrees of freedom significantly, this variable was not accounted for. Besides, beware that longer-range goals of RPS are likely to have much greater impact than year to year goals.

¹⁴ Actual energy demand changes were considered as independent variables. Initial tests of these variables did not show significant results. As a result, to maintain degrees of freedom, and for expediency reasons, these variables were not included in the analysis.

in green energy.¹⁵

- State Political Factors -- Obviously, states differ in their degree of readiness to adopt RPS standards, based on political differences. RPS is viewed by some as anti-utility legislation while others view it as a pro-economic development and energy security issue. Party politics and political ideology can not only impact on legislative adoption, but also on the adoption of collateral policies that can strengthen industry development, especially in the case of renewable energy. The notion that politics is important is supported by Huang et al. Two variables capturing state party dominance were used as proxies for political factors. The first is a dummy variable capturing the existence of democratic majority in the lower house (DEM-LH). The second is a dummy variable capturing the existence of democratic majority in the state senate (DEM-UH). The rationale for focusing on the legislature is that they ultimately decide on the strength of the RPS legislation and once legislation has passed, its implementation and effectiveness depends largely on other policy tools, which are largely under the control of the legislature.¹⁶

Wind Capacity Installation Determination Econometric Model

To determine the structure of wind capacity installation by states, the wind determination econometric model is specified. The model estimates the relationships between determinants of wind capability installation and installed wind capacity using the above discussed data. The model was specified as follows.

$$(1) \quad WINDCAP = \alpha_0 + \alpha_1 POPDEN + \alpha_2 URBAN\% + \alpha_3 GSP + \alpha_4 DEBT + \alpha_5 TAX + \alpha_6 DEMLH + \alpha_7 DEMUH + \alpha_8 PBF + \alpha_9 SYSBEN + \alpha_{10} GREEN + \alpha_{11} DISCLOSE + \alpha_{12} WINDPOETEN + \alpha_{13} RPS + \alpha_{14} RPS * TARGETYR + \alpha_{15} RPS * SINCERPS + \alpha_{16} RPS * RPS\% + \alpha_{17} RPS * REG + \varepsilon$$

where WINDCAP is total installed wind capacity by a state (or total MW of wind turbine generated electricity), and other variables are as described in Table 1 below. The parameters α_0 through α_{17} are coefficients to be estimated. Note that $RPS = 0$ for states that have not adopted legislation. The parameters α_0 through α_{12} capture the effects of non-RPS related factors, such as state characteristics, economic conditions, political interests, wind potential, and other factors. The parameters α_{13} through α_{17} measure the effects of RPS passage, given a set of specific RPS major characteristics. The specification above allows one to capture the impacts of RPS adoption as well as the decomposed effects of its component policies.

¹⁵ State growth rate (GRP) is excluded as an explanatory variable based on a determination via preliminary analysis that other factors, such as GSP, capture effects anticipated to be captured by the growth variable. Furthermore, if GRP were to be included in the model, in addition to forecasting GSP, forecasts of GRP would have to be generated in order to forecast installed wind capacity. Such a forecast would put too much weight on the economic situation of Michigan. The structural difference between the economy of Michigan and the economies of most states suggests the need to be cautious about including GRP as a variable.

¹⁶ It would be useful to consider the governor's party in the year of RPS adoption or in preceding years. However, our analysis suggests that the structure of the legislature, in large part, affects implementation, while the political and personal will of the governor affects leadership in introducing RPS as a legislative consideration.

As shown in equation 1 above, in specifying the RPS related variables, RPS was included as a slope containing dummy so that the effects of its components are triggered only in states where RPS has been adopted. Therefore, TARGETYR, SINCERPS, RPS%, and REG were crossed with the RPS dummy variable. This framework triggers these variables only for a state that adopts RPS.

Data and Estimation

Given the relative novelty of modern utility-scale wind power generation in the US, available data is relatively spotty. The two most reliable sources of data on the wind industry are NREL and the American Wind Energy Association (AWEA). NREL's estimate of wind capacity and installations provide the basic information on the status of the wind industry. Data on wind and renewable energy policies were generated from a variety of sources, including the American Wind Energy Association, the Green Power Network, and the Database of State Incentives for Renewables and Efficiency (DSIRE). Data on socio-economic and political factors were collected from the US Census Bureau (Census of Population and Census of Government) and the US Bureau of Economic Analysis. Data transformation was conducted to appropriately integrate the data and the modeling process. The Ordinary Least Squares (OLS) estimation method is used in estimating the Wind Capacity Installation Determination Model.

Table 1 provides a complete list and description of the variables used in estimating the wind capacity installation equation. The model has strong performance, with R^2 of 84%, (it explains 84% of the variation in state wind capacity installation).

Empirical Results

The parameter estimates presented above reflect a national average. Not only do they help explain the dynamics of wind capacity installation, they can also be used to forecast an individual state's future wind capacity installation. Such forecasts were developed for Michigan. However, before presenting these forecasts, the estimated impacts of each driver of wind installation are discussed in more detail.

Effects of State Economic Conditions

Based on the national analysis, state economic factors are found to impact on wind energy development. Higher Gross State Product is found to have a positive impact on installed wind capacity. For every billion dollars of GSP growth, new installed capacity of 2 MW is estimated. The finding that the size of a state's economy positively impacts on the growth of its installed wind energy capacity may suggest that large states (economically) face added pressure to push for policies that strengthen the gains from RPS adoption due to the high energy price tag and burdens, and the potential gains from economies of scale.

Accumulated public debt, however, was found to have a negative impact on wind energy installation. For every million dollars in total outstanding state debt, wind installed capacity is estimated to decline by 11.55 MW. This makes sense considering the fact that a state currently facing a huge debt burden from previous investment activities is less likely to

engage in the type of supplemental industrial reorganization policy required to maximize the benefits of RPS adoption.

The state economic condition variable, state per capita tax (TAX), was found not to be a statistically significant determinant of installed wind capacity. Hence, the wind capacity installation is not affected by a state's ability to tax.

Table 1: Identifying the Determinants of Wind Capacity Installation in the U.S. – Econometric Results.

| Variables | Model Estimates | | Variable Definition |
|---------------------------------------------------------------------------------|--------------------------|---------|------------------------------------------------------------------------------------------------------------|
| | Coefficient | p-value | |
| <i>Renewable Energy Policy and Wind Potential Factors</i> | | | |
| RPS | 497.88* | 0.06 | If a State adopted RPS = 1, otherwise = 0. |
| TARGETYR | -15.76* | 0.09 | Years to reach specified RPS target year. |
| SINCERPS | 21.86** | 0.04 | Duration of time since adoption of RPS (crossed with RPS dummy variable for states that have adopted RPS). |
| RPSRATE | -5.71 | 0.41 | The percentage of renewables in the total energy portfolio targeted in State RPS. |
| WNDPOTEN | 0.39*** | 0.00 | State wind potential by NREL at 50 meters (in billion kWh). |
| REG | -88.22 | 0.60 | If RPS is mandatory =1, otherwise = 0. |
| PBF | -121.64 | 0.26 | If a state adopted Public Benefits Fund = 1, otherwise = 0. |
| GREEN | 219.05** | 0.05 | If a state adopted a Mandatory Green Power Option = 1, otherwise = 0. |
| DISCLOSE | -134.38 | 0.12 | If state adopted Generation Disclosure Rules = 1, otherwise = 0. |
| <i>State Economic Condition Factors</i> | | | |
| GSP | 0.002*** | 0.00 | State GDP in \$ million. |
| DEBT | -1.2x10 ⁻⁴ ** | 0.01 | Total (short and long term) outstanding state debt in \$1,000. |
| TAX | 0.08 | 0.15 | State per capita Taxes in \$. |
| <i>State Characteristics Factors</i> | | | |
| POPDEN | -0.16 | 0.48 | State population density (population per square mile). |
| URBAN% | -01.89 | 0.48 | Percent of State population living in urban areas. |
| <i>State Political Factors</i> | | | |
| DEM-LH | -77.04 | 0.39 | Dummy Variable for Democratic majority in State Lower House. |
| DEM-UH | 219.63*** | 0.01 | Dummy Variable for Democratic majority in State Senate. |
| <i>Other</i> | | | |
| Intercept | -319.28 | 0.15 | Model intercept. |
| <i>Model Performance Indicators</i> | | | |
| R ² | | 0.84 | |
| Adjusted R ² | | 0.75 | |
| Log-Likelihood | | -384.66 | |
| F-value | | 9.77 | |
| F-Prob. Value | | 0.000 | |
| *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. | | | |

Effects of Political Conditions

The ultimate decision about post-adoption implementation of RPS is made by the state's legislature. The legislature's composition is also expected to affect the stringency of the provisions of an adopted RPS legislation. To explore whether the nature of a state's political composition influences wind energy development, the dominance of Democrats in the state's Lower House and Senate is estimated via dummy variables that take on the value of 1 when Democrats either control the Upper House (Senate) or the Lower House. Interestingly, a Democratic majority in the Lower House is found not to be a significant determinant of installed wind capacity. However, a Democratic majority in the State Senate is found to be a significant determinant of wind energy development.¹⁷ These results highlight the relevance of political influences in alternative energy development, and suggest that Democrats are more favorable to renewable energy and wind industry development.

Effects of Wind Potential

Wind potential provides a signal to industry that there are wind resources to tap. The estimated coefficient for state wind potential is 0.39, which suggests that for every one billion kilowatt hours (kWh) of state wind potential, installed wind capacity increases by 0.39 MW. This estimated coefficient is low, suggesting that even though existing wind potential has an influence on wind energy development, other policy factors have a much more substantial impact.

Effects of Other Factors

Despite the high R-squared, some hypothesized drivers of wind capacity installation were found not to be statistically significant drivers of installed wind capacity. Examples include DISCLOSE, PBF, POPDEN, REG, and URBAN%. DISCLOSE has little effect perhaps because the general public is not well informed about what the disclosures might mean, and various states probably have quite uneven disclosure requirements. Michigan's case is among the very best in the country, but enforcement has been quite lax. PBF may not be significant because limited PBF funding has gone to wind energy. POPDEN and URBAN% may be insignificant because wind generation is still relatively so small that installations have not bumped up, in any meaningful way, against land use limitations (even in highly populated states). REG may prove unimportant because a voluntary RPS could well carry an implied threat that if growth does not proceed apace, the RPS will be converted to mandatory (either by legislators or by voter referendum, which has now happened in Colorado and Washington).

Effects of RPS Legislation and its Inherent Factors

The impacts of whether or not a state adopts RPS on wind capacity installations are estimated. The results suggest that adoption and implementation of RPS would have a substantial positive effect on wind capacity installations, compared to states that do not adopt

¹⁷ We applied political data from 2006. Future refinement of this analysis will consider alternative measurement of party leadership and politics. The inclusion of the current variables should improve model efficacy. Since one of the goals was to predict wind installations, we suppressed the influence of these variables in our forecasts.

RPS legislation. RPS adoption alone, on average, would result in a 497.88 MW increase in annual capacity installation, compared to states that do not legislate in favor of RPS. In addition, for every year that passes since adoption, an additional shift factor will be added due to the effects of SINCERPS. SINCERPS, as a measure of the time that elapsed since a state's adoption of RPS, has a coefficient that is estimated to be 21.86 MW. Therefore, the basic passage of an RPS adds at least 520 MW of installed capacity for every additional year since RPS is placed in effect. These results suggest that, with time, wind capacity installation will grow after RPS adoption.

Another component of RPS legislation is the target year when a certain proportion of the energy supply portfolio must effectively contain renewable energy. The results suggest that the choice of the target year (number of years left to meet RPS standard) has significant impact on short and long-term rate of wind capacity installation. In other words, a target that is set further in the future will negatively affect current wind development rates, relatively, and more stringent and shorter target years have more wind development impacts. It is estimated that for every additional year that RPS target year is set, short-term wind capacity installation declines by 15.76 MW.¹⁸

The renewable energy policies of Public Benefits Fund and Generation Disclosure Rules did not seem to affect wind capacity installation. However, Mandatory Green Power Option¹⁹ has a substantial positive impact on wind development. States that adopted GREEN have on average 219.05 MW more installed wind capacity.

Projected Wind Capacity Installation for Michigan

The estimated parameters of the Wind Capacity Installation Determination Model are applied to Michigan's current conditions, including the characteristics of the Governor's proposed RPS legislation, in projecting wind capacity deployment in the state. The effects of variables that are not statistically significant are suppressed in calculating wind energy capacity installations. Only those variables that are significant (at the 90% significance level) are factored into the projections.

The basic contribution of RPS adoption to wind capacity installation is estimated to be 497.88 MW per year. In addition, the duration effect contribution of RPS is estimated to be 21.86 MW per year, and the Required Green Power Option Adoption component is estimated to be 219.05 MW per year. Furthermore, the wind potential effect is estimated to be 25.35 MW per year. Finally, the estimated effect of continued growth in state GDP, which is assumed to grow by 2% per year, on installed capacity varies from 15.55 MW for 2008 to 23.56 MW in

¹⁸ It would be desirable to evaluate the relationship between interim or mid-term RPS targets and growth in installed wind capacity. However, not every state has passed policies that involve such interim targets.

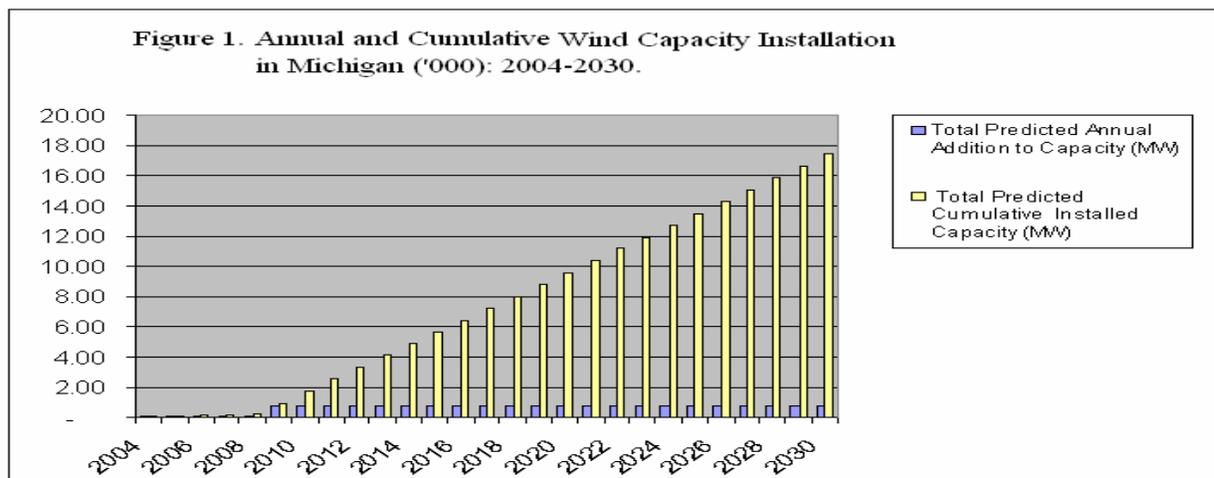
¹⁹ Mandatory Green Power Option provides electricity customers an option to purchase energy generated from renewable energy sources produced by utilities, or in some cases by contracting or purchasing credits from another renewable energy provider (DSIRE, Accessed November 15, 2007 at <http://www.dsireusa.org>). It requires electricity suppliers to offer customers a green power option, whereby the supplier will purchase a portion or all of the customer's usage from electricity generated by renewable resources.

2029. These factors combined contribute to an expected annual capacity installation increase of 780 MW.

In sum, for Michigan it is estimated that, by adopting the legislation in 2007, the total installed capacity, which is currently at 3 MW, will grow substantially. Wind projects are already underway in the Thumb Area of Michigan, which will bring Michigan’s installed capacity to nearly 60 MW by the end of 2007. Our model predicts that following RPS adoption, there would be a surge in wind turbine installations in Michigan. From the current 60 MW in operation or planned, by 2009 there would be an estimated 981 MW in place; by 2010, there would be an estimated 1,762 MW in place; and by the year 2020, a total of 9,584 MW will be installed. Using this model, and based on NREL’s estimate of approximately 16,000 MW of on-shore wind energy development potential for Michigan, Michigan wind energy potential could reach a saturation point by as early as 2029. The estimated deployed capacity in 2029 is 16,657 MW.

The projected yearly and cumulative installations of wind towers in MW are shown in Appendix I and they are further illustrated in Figure 1. NREL estimates Michigan’s wind capacity to be approximately 16,000 MW, based on wind measurements at 50 meters.²⁰ Figure 1 shows that Michigan can achieve this capacity within the next 22 years.

The total growth in wind energy installations, post-RPS, is the sum of the effects of RPS legislation and the effects of non-RPS factors. Note that most of the projected growth in installed wind capacity is related to RPS legislation. For example, 738.8 of the 780 MW projected installations for 2009 (94.72%) is due to RPS legislation adoption. Similarly, at 93.78%, for the contribution of RPS in 2029, the RPS effect is still strong. One basic conclusion from this study is that RPS would make a huge difference in the evolution of the wind industry in Michigan. The Required Green Option Adoption alone accounts for 30% of the projected RPS effect. Obviously, meeting the target set by the Governor would be enhanced significantly by features of the RPS legislation.



²⁰ Wind turbine productivity has been rapidly increasing in recent years due to technological improvements. Most new installations are at tower heights of 70 to 80 meters, where the wind resource is much greater than at 50 meters.

Projected Economic Impacts

The results above suggest that the adoption of RPS, with the characteristics defined by Governor Granholm's 21st Century Electric Energy Plan, will result in a significant increase in the installation of wind energy capacity in Michigan. Such installations, which have been shown to be largely impacted by RPS adoption, are expected to have significant long-term economic impacts.

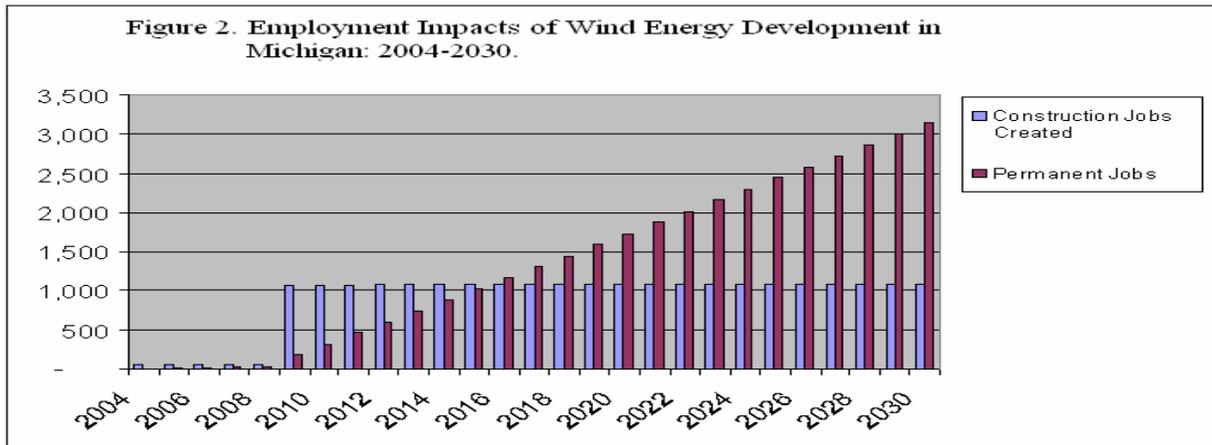
Wind energy deployment has two categories of direct economic impacts. The first relates to the construction aspects of wind systems, and these are quite significant. The second relates to ongoing management and maintenance, and these tend to grow over time as the installed wind capacity (turbines) increases over time requiring more management and maintenance expenditures. While construction related jobs dominate the economic impact in the beginning phases of wind energy deployment in a State, the recurrent impacts dominate in the long-run. Therefore, it is valuable to document both dimensions. In calculating the economic impacts of wind energy deployment, the following components of construction and ongoing maintenance activities were identified:

- Impacts related to construction activities – The construction of wind turbines is very capital and labor intensive. For example, based on the JEDI model estimate, 1 MW is expected to cost approximately \$1.6 million in construction investment, some of which goes towards labor. Currently, few of the turbine components are manufactured in Michigan. A goal of public policy in Michigan should be to intensify the application of Michigan's manufacturing capacity toward wind energy so that more of the industry's impacts can be felt at home. The estimated wages paid in the construction process is approximately \$27,000/MW. JEDI's estimate of construction jobs per megawatt is 1.38. In calculating the economic impact from construction, we assumed that none of the components will come from Michigan. However, the total investment costs represent the potential for Michigan to capture a larger share of the supply chain. NextEnergy recently estimated that two dozen Michigan companies currently manufacture wind turbine components. However, the extent to which these companies would service wind installations in Michigan is unknown.
- Impacts related to maintenance and long-term management activities – Each year, as new capacity is deployed, construction benefits accrue. However, once a facility is built, it adds to the total capacity of the state from which employment, income, and land leases can be generated continuously. It is estimated by JEDI that for 1.5 MW wind generators, each installed megawatt of capacity translates to approximately \$263,000 in recurrent spending; \$5,500 in labor cost and \$2,689 in land lease payments to farmers and other land owners. JEDI's estimate of management and maintenance jobs per megawatt is 0.18 jobs.

To estimate the economic impacts of the projected wind energy capacity deployment, the JEDI model was used to extract per megawatt multipliers which were used in translating projected installed capacity into information on construction investments, construction related jobs, construction related wages, land leases for wind turbines, ongoing maintenance investments and wages, and long-term maintenance and management related employment. Note that these estimates do not include secondary impacts due to spending and employment multipliers.

Jobs Created

Appendix II shows the predicted job creation impact of wind energy installations. Starting with the construction side, the adoption of RPS in Michigan is expected to result in approximately 1,073 to 1,084 new construction jobs per year in the State over the next 22 years. No indirect job creation impacts are assumed in this analysis, but the usual employment multiplier of 1.5 would yield roughly an additional 500 jobs. Recurring maintenance and management jobs related to wind energy are expected to grow from about 318 in 2010 to 3,153 jobs in 2029. Figure 2 illustrates the growth in employment in the State as a result of wind energy deployment.²¹



²¹Under a 20-year scenario that includes 8% renewables by 2010 and 22% renewables by 2020, Hewings, et al (2001) estimated job impacts of 4,100 by 2010 and 9,100 by 2020. Under a 20% RPS by 2020, Kammen, et. al. (2004) estimated that renewable energy can create 1.9 to 2.1 times more life-cycle jobs than fossil fuel scenarios. The Union of Concerned Scientists (2004) also estimated that renewable energy produces 2.3 times more jobs as fossil fuels. The Union of Concerned Scientists (2007) further estimates (under a 20% RPS for Michigan) that by 2020, 3,540 new jobs will be created. Madsen, et al. (2007) investigated the impact of a 25% RPS by 2025 and a \$225 million energy efficiency program and concluded that the job impacts will be 7,000. Polich, et al. (2007) also conducted impact assessment on a 7% RPS by 2015 or 15% by 2025 and found that the job impact will be 6,400. Our job impact estimates are generally similar to estimates from prior studies. For citations on these studies, see the following:

Hewings, G., M. Yanai, et al. (2001). *Job Jolt: The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland with Clean, Renewable and Efficient Energy*. Chicago, IL: Environmental Law and Policy Center; <http://www.repowermidwest.org>.

Kammen, D. M., K. Kapadia, et al. (2004). *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* Berkeley, CA: University of California, Berkeley; Renewable and Appropriate Energy Laboratory; <http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf>.

Union of Concerned Scientists (2004). *Renewing america's economy*. Washington, DC: Union of Concerned Scientists.

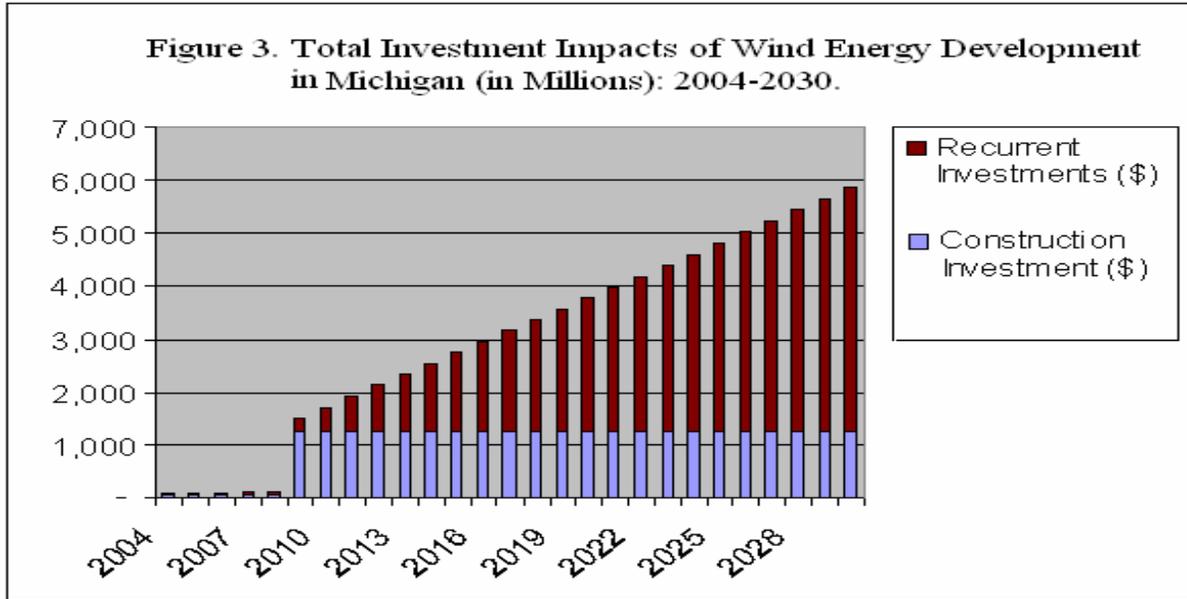
Union of Concerned Scientists (2007). *Cashing in on Clean Energy*. Washington, DC: Union of Concerned Scientists; http://www.ucsusa.org/clean_energy/clean_energy_policies/cashing-in.html.

Madsen, T., T. Telleen-Lawton, et al. (2007). *Energizing Michigan's Economy: Creating Jobs and Reducing Pollution with Energy Efficiency and Renewable Electric Power*. Ann Arbor, MI: Environment Michigan

Polich, R., J. Amlin, et al. (2007). *A Study of Economic Impacts from the Implementation of a Renewable Portfolio Standard and an Energy Efficiency Program in Michigan*. Lansing, MI: Michigan Department of Environmental Quality.

Investment and Spending

Appendix II shows the predicted investment and spending impacts of wind energy installations. The adoption of RPS in Michigan is further projected to result in approximately \$1.25 billion per year in construction related new investments, and total ongoing annual spending and ongoing maintenance investment is projected to equal an additional \$464 million by 2010, and \$4.6 billion by 2030. Figure 3 illustrates the growth in investments and spending in the State as a result of wind energy deployment.²² Total investment level is broken down into recurrent and construction investment.



Wages and Earnings

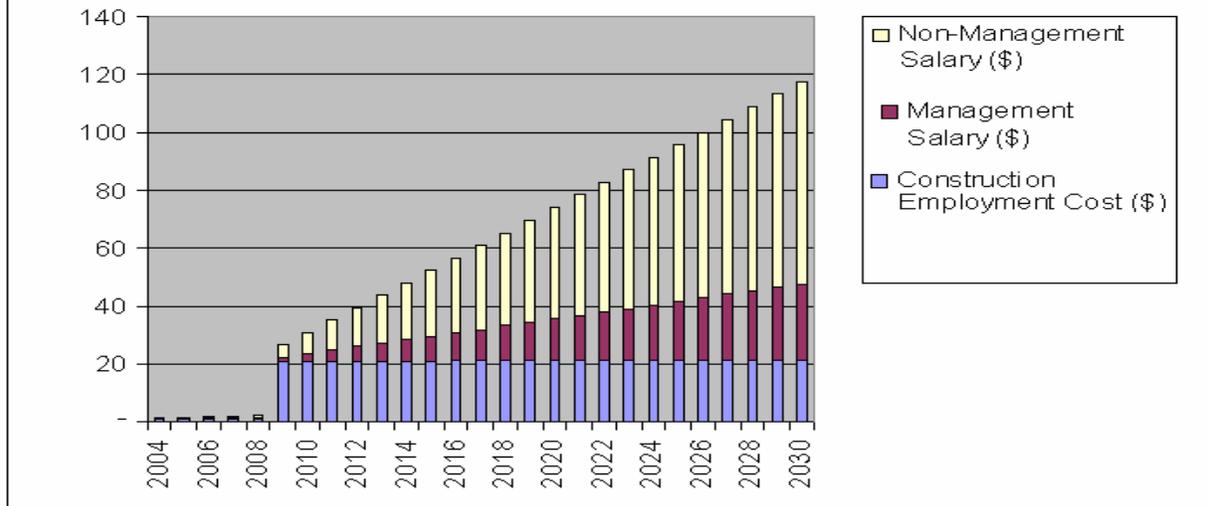
Appendix II shows the predicted wage impacts of wind energy installations. Wages and earnings are projected to generate \$21 million in new construction wages annually. The estimates for recurrent wages range from \$7.6 million in 2010 to \$96 million in 2030. Figure 4 illustrates the new wages and earnings as a result of wind energy deployment.²³

²² Under a 20% RPS scenario by 2020, the Union of Concerned Scientists (2004) estimated \$1.2 billion in new capital investment in Michigan. Sterzinger and Stevens (2006) estimated, under the scenario of 18,500 MW of new renewable energy in the U.S. each year for 10 years, an investment impact on Michigan of \$5.3 billion. Even though the two studies have different assumptions, the estimated investment impacts are reasonably comparable.

²³ Polich, et al. (2007) estimated the disposable income impact of a 7% RPS by 2016 or 15% by 2025 to be \$415 or \$664 million, respectively. Our study assumes no impact on disposable income outside of income earned on the installation and operation of wind turbines. Therefore, our wage and earnings impacts are significantly lower than those estimated by Polich, et al.. For citation on this study, see the following:

Polich, R., J. Amlin, et al. (2007). A Study of Economic Impacts from the Implementation of a Renewable Portfolio Standard and an Energy Efficiency Program in Michigan. Lansing, MI: Michigan Department of Environmental Quality.

Figure 4. Total Wage Impacts of Wind Energy Development in Michigan (in Millions): 2004-2030.



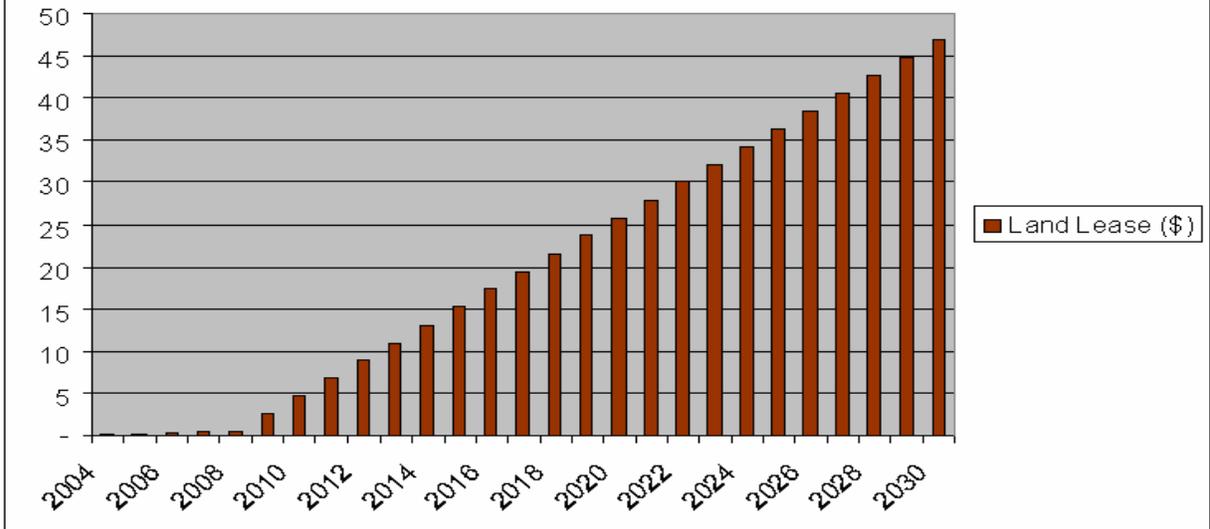
Lease Payments

Farmers and other land owners are expected to reap significant benefits from wind development land lease payments. Appendix II provides estimated lease payments to landowners as a result of wind turbine installations. Lease payments to farmers are estimated to range between \$5 million in 2010 and \$47 million in 2030. The current net farm income in agriculture in Michigan is approximately \$724 million. The areas of the State with the best wind capacity represent less than 5% of the land area in the State. Hence, much of the lease payment impact of wind will be concentrated in specific communities. Similar to recent experiences in other states, it is estimated that farmers whose land is leased for wind energy development are likely to generate as much or more income from land leases as they presently do from their existing agricultural operations. Figure 5 illustrates the land lease payments impact of wind energy deployment.²⁴

We would like to stress again that the above estimates do not include any secondary employment, wage or spending impacts. They also do not include the impacts of property tax payments to local units of government and business or income tax payments to the state government. The Michigan Economic Development Corporation is currently seeking legal interpretations regarding how wind installations will be considered and valued at the local level for the purpose of property tax assessment.

²⁴ The Union of Concerned Scientists (2004) estimated that with a 20% national RPS scenario by 2020, and based on some other assumptions, the impact on Michigan will include \$429 million in income to farmers and rural land owners. The estimates of land lease impacts from their study are above the cumulative impact estimates through 2020 in our study (See Appendix II for cumulative 2020 land lease impacts).

**Figure 5. Land Lease Impacts of Wind Energy Development in Michigan
(in Millions): 2004-2030.**



These estimates also do not include the impacts on Michigan if the State’s manufacturing capacity were to be deployed toward the production of wind turbines and components. If Michigan’s manufacturing capacity could be brought to bear on wind components manufacturing, Michigan could capture larger percentage of the total spending on wind components by developers, which is estimated to be \$1.25 billion per year in construction investment and spending and \$4.6 billion per year in recurrent spending by 2030.

These estimates also do not include the possibility that Michigan component manufacturers can supply wind systems to other states in the region and beyond. Michigan is strategically located on the Great Lakes. This makes the shipment of large components such as towers and blades easier to accomplish, especially considering the fact that the likely sites in other nearby states are also largely near the coasts. Given the wind resource in the Great Lakes states to which large components could be easily deployed, the economic impact of a strategic and competitive wind industry development program could provide a viable economic strategy for Michigan.

Summary and Conclusions

Michigan is currently considering the adoption of a renewable portfolio standard (RPS) legislation to spur the development of alternative energy in the State. Twenty-six states have already passed mandatory RPS legislation. The level of maturity of the alternative energy industry in these states suggests, anecdotally, that RPS is a key ingredient to renewable energy development. This study adds to the anecdotal evidence by suggesting that the adoption of RPS and the provisions of such legislation will spur wind energy development.

In the area of wind energy in which Michigan is very well endowed in terms of total capacity, there is growing interest in the role that wind energy can play in the economic transformation of the State. The fact that Michigan has significant idle wind development potential is seen as an opportunity, as rapid wind turbine installation in the State could spur the further development of wind generator component manufacturers.

This study utilizes data from all 50 states in estimating a structural model of wind industry development which accounts for the adoption of RPS, the particular characteristics of RPS legislation adopted, and other drivers of wind energy development, such as state growth, energy policy factors, and political factors. It was found that RPS legislative adoption has been key to the growth of the industry in states where such legislation was adopted. It was also shown that wind potential of a state is a driver of wind industry development; that state economic growth is a relevant driver; that wind energy development is more encouraged by shorter time lines for meeting RPS requirements; that there is a momentum effect associated with duration since RPS adoption; that states with a Democratic majority in the state senate tend to more favorably develop their wind industry; and that states experiencing high public debt tend to experience a much slower wind energy development process. The basic structural parameters from this model are then used to forecast Michigan's wind energy development post RPS adoption.

A significant annual increase in installation of wind turbines is expected following the adoption of RPS. Approximately 780 megawatts of wind turbines is expected to be installed per year in Michigan, 95% of which is directly related to RPS adoption including, in some states, a mandate for electricity suppliers to offer customers a green rate option. Without the adoption of RPS, the wind industry in Michigan is not likely to take off, but it appears primed for early rapid growth if an RPS is adopted.

The economic impacts of RPS adoption are calculated, with a focus on total spending, wages, jobs created, and lease payments to farmers. It is anticipated that approximately 1,100 new construction jobs per year will be created in the State. Recurring (permanent) maintenance and management jobs are projected to be 318 by 2010, and 3,153 jobs by 2030. For a green industry and only one component of renewable energy, these are substantial numbers.

RPS legislative adoption is expected to spur \$1.25 billion per year in construction related new wind energy investments and spending. The projected annual spending on wind generator maintenance and management ranges from \$464 million in 2010 to \$4.6 billion in 2030.

Wind energy is projected to generate \$21 million per year in new construction wages. It will also generate between \$7.6 million and \$96 million in permanent wages in 2010 and 2030, respectively.

Finally, one area that looks promising, due to the concentration of its effects, is lease payments to farmers and land owners. The estimated lease payments to farmers will range from \$5 million in 2010 to \$47 million by 2030. Hence, the few farmers whose land is well positioned to support wind power development will profit significantly. At almost \$3,000 per acre (some farmers receive substantially more), wind is an interesting potential source of alternative income for farmers.

We offer no policy recommendation other than the adoption of good RPS legislation. Since features of RPS legislation can accelerate wind installation (through the target date and percent renewable goals), RPS legislation needs to consider the importance of legislative provisions. Given intensifying interests by utilities and developers, the legislature must balance the energy independence benefits, the industry development benefits, benefits to farmers, and the environmental impacts of RPS against pressures from opponents.

APPENDIX I

Projected Yearly and Cumulative Installations of Wind Capacity for Michigan in Megawatts (MW): 2004 - 2030²⁵

| PREDICTED WIND CAPACITY INSTALLATION | | |
|---------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------|
| Year | Total Predicted Annual Addition to Capacity (MW) | Total Predicted Cumulative Installed Capacity (MW) |
| 2004 | 39.71 | 39.71 |
| 2005 | 40.00 | 79.71 |
| 2006 | 40.29 | 120.00 |
| 2007 | 40.59 | 160.59 |
| 2008 | 40.90 | 201.49 |
| 2009 | 780.00 | 981.49 |
| 2010 | 780.32 | 1761.81 |
| 2011 | 780.64 | 2542.45 |
| 2012 | 780.97 | 3323.43 |
| 2013 | 781.31 | 4104.74 |
| 2014 | 781.65 | 4886.39 |
| 2015 | 782.00 | 5668.39 |
| 2016 | 782.36 | 6450.75 |
| 2017 | 782.72 | 7233.48 |
| 2018 | 783.10 | 8016.57 |
| 2019 | 783.48 | 8800.05 |
| 2020 | 783.86 | 9583.91 |
| 2021 | 784.26 | 10368.17 |
| 2022 | 784.66 | 11152.83 |
| 2023 | 785.07 | 11937.89 |
| 2024 | 785.49 | 12723.38 |
| 2025 | 785.91 | 13509.30 |
| 2026 | 786.35 | 14295.64 |
| 2027 | 786.79 | 15082.44 |
| 2028 | 787.25 | 15869.68 |
| 2029 | 787.71 | 16657.39 |
| 2030 | 788.18 | 17445.57 |

²⁵ Note that our econometric model utilized wind potential and other data for 2003 and related years. As a result, even though actual values for 2004-2007 are already known, the model predictions for these years are utilized for consistency reasons. The model continues to project to subsequent years.

Appendix II

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Projection Coefficient | Predictions | | | |
|-------------------------------------------------------------------|------------------------|-------------|-------------------------|-------------------------|-------------------------|
| | | 2003 | 2004 | 2005 | 2006 |
| PROJECTION INPUTS | | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.885 | - | - | - | - |
| Duration Since RPS Adoption Effect/Year (2) | 21.862 | - | - | - | - |
| Required Green Power Option Adoption Effect/Year (3) | 219.046 | - | - | - | - |
| Effect of RPS Adoption on Wind Installation (with 1-3) | | - | - | - | - |
| Projected State GDP at 2% per year | | 359,030.00 | 366,210.60 | 373,534.81 | 381,005.51 |
| Estimated State GDP Coef. (.002) | 0.002 | - | - | - | - |
| GDP Growth Effect on Wind Installation | | - | 14.36 | 14.65 | 14.94 |
| Estimated Wind Potential Coefficient (0.39) | 0.39 | | | | |
| Wind Potential Effect on Wind Installation | | | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | | |
| Total Predicted Annual Addition to Capacity (MW) | | | 39.71 | 40.00 | 40.29 |
| Total Predicted Cumulative Installed Capacity (MW) | | | 39.71 | 79.71 | 120.00 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | | |
| | \$/MW | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,600,000.00 | | \$ 63,537,920.00 | \$ 63,997,478.40 | \$ 64,466,227.97 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 27,091.95 | | \$ 1,075,853.96 | \$ 1,083,635.42 | \$ 1,091,572.50 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1.38 | | 55 | 55 | 55 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 263,362.60 | | \$ 10,458,444.84 | \$ 20,992,533.73 | \$ 31,603,779.57 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 2,689.27 | | \$ 106,793.96 | \$ 214,360.34 | \$ 322,714.60 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 1,507.87 | | \$ 59,879.20 | \$ 120,191.49 | \$ 180,945.54 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 4,007.09 | | \$ 159,126.35 | \$ 319,403.63 | \$ 480,854.86 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 0.18 | | 7 | 14 | 22 |
| TOTAL NEW INVESTMENTS (\$) | | | \$ 73,996,364.84 | \$ 84,990,012.13 | \$ 96,070,007.54 |
| TOTAL WAGES (\$) | | | \$ 1,294,859.50 | \$ 1,523,230.53 | \$ 1,753,372.90 |
| TOTAL LAND LEASE PAYMENTS (\$) | | | \$ 106,793.96 | \$ 214,360.34 | \$ 322,714.60 |
| TOTAL EMPLOYMENT (Jobs) | | | 62 | 69 | 77 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|-------------------------------------------------------------------|--------------------------|--------------------------|----------------------------|----------------------------|
| | 2007 | 2008 | 2009 | 2010 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | - | RPS Legislated | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | - | RGPO Legislated | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | - | - | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | - | - | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 368,625.62 | 396,398.13 | 404,326.09 | 412,412.62 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 15.24 | 15.55 | 15.86 | 16.17 |
| Estimated Wind Potential Coefficient (0.39) | - | - | - | - |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 40.59 | 40.90 | 780.00 | 780.32 |
| Total Predicted Cumulative Installed Capacity (MW) | 160.59 | 201.49 | 981.49 | 1,761.81 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 64,944,352.53 | \$ 65,432,039.58 | \$ 1,248,004,680.37 | \$ 1,248,512,069.98 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 1,099,668.33 | \$ 1,107,926.08 | \$ 21,131,802.45 | \$ 21,140,393.81 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 56 | 56 | 1,073 | 1,073 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 42,293,725.48 | \$ 53,063,945.48 | \$ 258,487,542.99 | \$ 463,994,657.66 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 431,872.48 | \$ 541,850.06 | \$ 2,639,485.04 | \$ 4,737,972.85 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 242,150.18 | \$ 303,814.42 | \$ 1,479,954.85 | \$ 2,656,573.46 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 643,503.53 | \$ 807,373.57 | \$ 3,932,915.44 | \$ 7,059,728.03 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 29 | 36 | 177 | 318 |
| TOTAL NEW INVESTMENTS (\$) | \$ 107,238,078.01 | \$ 118,495,985.06 | \$ 1,506,492,223.36 | \$ 1,712,506,727.64 |
| TOTAL WAGES (\$) | \$ 1,985,322.04 | \$ 2,219,114.07 | \$ 26,544,672.74 | \$ 30,856,695.29 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 431,872.48 | \$ 541,850.06 | \$ 2,639,485.04 | \$ 4,737,972.85 |
| TOTAL EMPLOYMENT (Jobs) | 85 | 93 | 1,250 | 1,392 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|-------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | 2011 | 2012 | 2013 | 2014 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.89 | 497.89 | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | 21.86 | 21.86 | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | 219.05 | 219.05 | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | 738.80 | 738.80 | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 420,660.87 | 429,074.08 | 437,655.57 | 446,408.68 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 16.50 | 16.83 | 17.16 | 17.51 |
| Estimated Wind Potential Coefficient (0.39) | | | | |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 780.64 | 780.97 | 781.31 | 781.65 |
| Total Predicted Cumulative Installed Capacity (MW) | 2,542.45 | 3,323.43 | 4,104.74 | 4,886.39 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,249,029,607.38 | \$ 1,249,557,495.52 | \$ 1,250,095,941.43 | \$ 1,250,645,156.26 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 21,149,157.00 | \$ 21,158,095.45 | \$ 21,167,212.67 | \$ 21,176,512.23 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1,074 | 1,074 | 1,075 | 1,075 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 669,586,959.83 | \$ 875,266,153.24 | \$ 1,081,033,975.72 | \$ 1,286,892,199.86 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 6,837,330.52 | \$ 8,937,575.46 | \$ 11,038,725.42 | \$ 13,140,798.49 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 3,833,679.80 | \$ 5,011,283.63 | \$ 6,189,394.90 | \$ 7,368,023.76 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 10,187,836.75 | \$ 13,317,267.54 | \$ 16,448,046.83 | \$ 19,580,201.58 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 459 | 601 | 742 | 883 |
| TOTAL NEW INVESTMENTS (\$) | \$ 1,918,616,567.20 | \$ 2,124,823,648.76 | \$ 2,331,129,917.16 | \$ 2,537,537,356.12 |
| TOTAL WAGES (\$) | \$ 35,170,673.55 | \$ 39,486,646.61 | \$ 43,804,654.39 | \$ 48,124,737.57 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 6,837,330.52 | \$ 8,937,575.46 | \$ 11,038,725.42 | \$ 13,140,798.49 |
| TOTAL EMPLOYMENT (Jobs) | 1,533 | 1,675 | 1,816 | 1,958 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|-------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | 2015 | 2016 | 2017 | 2018 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.89 | 497.89 | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | 21.86 | 21.86 | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | 219.05 | 219.05 | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | 738.80 | 738.80 | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 455,336.85 | 464,443.59 | 473,732.46 | 483,207.11 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 17.86 | 18.21 | 18.58 | 18.95 |
| Estimated Wind Potential Coefficient (0.39) | | | | |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 782.00 | 782.36 | 782.72 | 783.10 |
| Total Predicted Cumulative Installed Capacity (MW) | 5,668.39 | 6,450.75 | 7,233.48 | 8,016.57 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,251,205,355.39 | \$ 1,251,776,758.50 | \$ 1,252,359,589.67 | \$ 1,252,954,077.46 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 21,185,997.78 | \$ 21,195,673.05 | \$ 21,205,541.82 | \$ 21,215,607.97 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1,075 | 1,076 | 1,076 | 1,077 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 1,492,842,633.68 | \$ 1,698,887,121.38 | \$ 1,905,027,544.04 | \$ 2,111,265,820.36 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 15,243,813.14 | \$ 17,347,788.20 | \$ 19,452,742.88 | \$ 21,558,696.77 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 8,547,180.56 | \$ 9,726,875.86 | \$ 10,907,120.43 | \$ 12,087,925.25 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 22,713,759.32 | \$ 25,848,748.10 | \$ 28,985,196.54 | \$ 32,123,133.83 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 1,024 | 1,166 | 1,307 | 1,449 |
| TOTAL NEW INVESTMENTS (\$) | \$ 2,744,047,989.07 | \$ 2,950,663,879.88 | \$ 3,157,387,133.71 | \$ 3,364,219,897.81 |
| TOTAL WAGES (\$) | \$ 52,446,937.66 | \$ 56,774,297.01 | \$ 61,097,858.79 | \$ 65,426,667.05 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 15,243,813.14 | \$ 17,347,788.20 | \$ 19,452,742.88 | \$ 21,558,696.77 |
| TOTAL EMPLOYMENT (Jobs) | 2,100 | 2,242 | 2,384 | 2,526 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|-------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | 2019 | 2020 | 2021 | 2022 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.89 | 497.89 | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | 21.86 | 21.86 | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | 219.05 | 219.05 | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | 738.80 | 738.80 | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 492,871.25 | 502,728.68 | 512,783.25 | 523,038.92 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 19.33 | 19.71 | 20.11 | 20.51 |
| Estimated Wind Potential Coefficient (0.39) | | | | |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 783.48 | 783.86 | 784.26 | 784.66 |
| Total Predicted Cumulative Installed Capacity (MW) | 8,800.05 | 9,583.91 | 10,368.17 | 11,152.83 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,253,560,455.01 | \$ 1,254,178,960.11 | \$ 1,254,809,835.31 | \$ 1,255,453,328.02 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 21,225,875.44 | \$ 21,236,348.26 | \$ 21,247,030.53 | \$ 21,257,926.46 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1,077 | 1,078 | 1,079 | 1,079 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 2,317,603,907.40 | \$ 2,524,043,801.39 | \$ 2,730,587,538.46 | \$ 2,937,237,195.48 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 23,665,669.85 | \$ 25,773,682.51 | \$ 27,882,755.54 | \$ 29,992,910.14 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 13,269,301.54 | \$ 14,451,260.71 | \$ 15,633,814.44 | \$ 16,816,974.60 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 35,262,589.75 | \$ 38,403,594.68 | \$ 41,546,179.59 | \$ 44,690,376.08 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 1,590 | 1,732 | 1,874 | 2,015 |
| TOTAL NEW INVESTMENTS (\$) | \$ 3,571,164,362.41 | \$ 3,778,222,761.50 | \$ 3,985,397,373.77 | \$ 4,192,690,523.49 |
| TOTAL WAGES (\$) | \$ 69,757,766.73 | \$ 74,091,203.65 | \$ 78,427,024.56 | \$ 82,765,277.13 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 23,665,669.85 | \$ 25,773,682.51 | \$ 27,882,755.54 | \$ 29,992,910.14 |
| TOTAL EMPLOYMENT (Jobs) | 2,668 | 2,810 | 2,952 | 3,095 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|-------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | 2023 | 2024 | 2025 | 2026 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.89 | 497.89 | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | 21.86 | 21.86 | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | 219.05 | 219.05 | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | 738.80 | 738.80 | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 533,499.69 | 544,169.69 | 555,053.08 | 566,154.14 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 20.92 | 21.34 | 21.77 | 22.20 |
| Estimated Wind Potential Coefficient (0.39) | | | | |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 785.07 | 785.49 | 785.91 | 786.35 |
| Total Predicted Cumulative Installed Capacity (MW) | 11,937.89 | 12,723.38 | 13,509.30 | 14,295.64 |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,256,109,690.58 | \$ 1,256,779,180.39 | \$ 1,257,462,060.00 | \$ 1,258,158,597.20 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 21,269,040.30 | \$ 21,280,376.41 | \$ 21,291,939.25 | \$ 21,303,733.35 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1,080 | 1,080 | 1,081 | 1,081 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 3,143,994,890.84 | \$ 3,350,862,785.31 | \$ 3,557,843,082.87 | \$ 3,764,938,031.59 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 32,104,167.96 | \$ 34,216,551.04 | \$ 36,330,081.91 | \$ 38,444,783.50 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 18,000,753.32 | \$ 19,185,162.99 | \$ 20,370,216.21 | \$ 21,555,925.87 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 47,836,216.39 | \$ 50,983,733.39 | \$ 54,132,960.61 | \$ 57,283,932.27 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 2,157 | 2,299 | 2,441 | 2,583 |
| TOTAL NEW INVESTMENTS (\$) | \$ 4,400,104,581.42 | \$ 4,607,041,965.70 | \$ 4,815,305,142.87 | \$ 5,023,096,628.79 |
| TOTAL WAGES (\$) | \$ 87,106,010.01 | \$ 91,449,272.79 | \$ 95,795,116.08 | \$ 100,143,591.48 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 32,104,167.96 | \$ 34,216,551.04 | \$ 36,330,081.91 | \$ 38,444,783.50 |
| TOTAL EMPLOYMENT (Jobs) | 3,237 | 3,380 | 3,522 | 3,665 |

Appendix II (Continued)

Projected Economic Impacts of Wind Capacity Installations for Michigan: 2004 – 2030.

| | Predictions | | | |
|---------------------------------------------------------------------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | 2027 | 2028 | 2029 | 2030 |
| PROJECTION INPUTS | | | | |
| Basic RPS Adoption Effect per Year (1) | 497.89 | 497.89 | 497.89 | 497.89 |
| Duration Since RPS Adoption Effect/Year (2) | 21.86 | 21.86 | 21.86 | 21.86 |
| Required Green Power Option Adoption Effect/Year (3) | 219.05 | 219.05 | 219.05 | 219.05 |
| Effect of RPS Adoption on Wind Installation (with 1-3) | 738.80 | 738.80 | 738.80 | 738.80 |
| Projected State GDP at 2% per year | 577,477.23 | 589,026.77 | 600,807.31 | 612,823.45 |
| Estimated State GDP Coef. (.002) | - | - | - | - |
| GDP Growth Effect on Wind Installation | 22.65 | 23.10 | 23.56 | 24.03 |
| Estimated Wind Potential Coefficient (0.39) | | | | |
| Wind Potential Effect on Wind Installation | 25.35 | 25.35 | 25.35 | 25.35 |
| WIND CAPACITY INSTALLATION FORECASTS | | | | |
| Total Predicted Annual Addition to Capacity (MW) | 786.79 | 787.25 | 787.71 | 788.18 |
| Total Predicted Cumulative Installed Capacity (MW) | 15,082.44 | 15,869.68 | 16,657.39 | 17,445.57 |
| Full Capacity Installation Based on NREL 50 meter Wind Density Estimate for Michigan | | | | |
| FORECASTED ECONOMIC IMPACT OF WIND TURBINE INSTALLATIONS | | | | |
| Construction Investment (\$) [(Invest/MW)]*[New Installed MW] | \$ 1,258,869,065.14 | \$ 1,259,593,742.44 | \$ 1,260,332,913.29 | \$ 1,261,086,867.56 |
| Construction Employment Cost (\$) [(Cost/MW)]*[New Installed MW] | \$ 21,315,763.32 | \$ 21,328,033.90 | \$ 21,340,549.89 | \$ 21,353,316.20 |
| Construction Jobs Created (People) [(Jobs/MW)]*[New Installed MW] | 1,082 | 1,083 | 1,083 | 1,084 |
| Recurrent Investments (\$) [(Investment/MW)]*[Installed MW] | \$ 3,972,149,924.48 | \$ 4,179,481,100.44 | \$ 4,386,933,945.12 | \$ 4,594,510,891.90 |
| Land Lease (\$) [(Lease Payment/MW)]*[Installed MW] | \$ 40,560,679.25 | \$ 42,677,793.02 | \$ 44,796,149.19 | \$ 46,915,772.60 |
| Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 22,742,305.07 | \$ 23,929,367.23 | \$ 25,117,125.99 | \$ 26,305,595.30 |
| Non-Management Salary (\$) [(Salary/MW)]*[Installed MW] | \$ 60,436,683.24 | \$ 63,591,249.11 | \$ 66,747,666.19 | \$ 69,905,971.50 |
| Permanent Jobs (People) [(Jobs/MW)]*[Installed MW] | 2,726 | 2,868 | 3,010 | 3,153 |
| TOTAL NEW INVESTMENTS (\$) | \$ 5,231,018,989.63 | \$ 5,439,074,842.88 | \$ 5,647,266,858.41 | \$ 5,855,597,759.45 |
| TOTAL WAGES (\$) | \$ 104,494,751.64 | \$ 108,848,650.24 | \$ 113,205,342.08 | \$ 117,564,882.99 |
| TOTAL LAND LEASE PAYMENTS (\$) | \$ 40,560,679.25 | \$ 42,677,793.02 | \$ 44,796,149.19 | \$ 46,915,772.60 |
| TOTAL EMPLOYMENT (Jobs) | 3,808 | 3,951 | 4,094 | 4,237 |