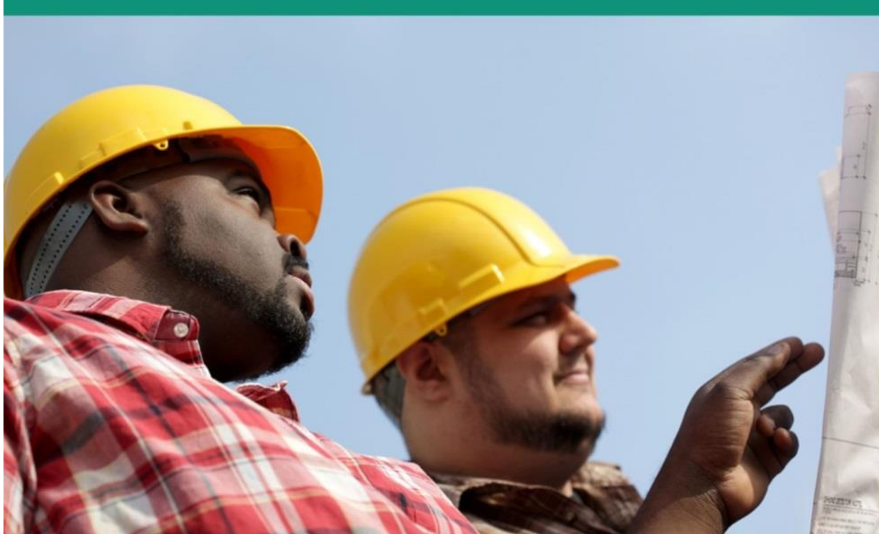
Michigan Conservative Energy Forum

Economic Impact of Two Renewable Portfolio Standard Scenarios in Michigan, 2015 to 2025



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EXECUTIVE SUMMARY

Recent shifts in national energy policy have championed the growth of renewable energy as part of an "all of the above" energy development strategy. To promote increased investment in renewable energy and capitalize on the renewable resources found within the state, Michigan adopted Public Act 295 of 2008.[1] This act set a renewable portfolio standard (RPS) that requires electric providers to generate 10 percent of electricity sales from renewable energy sources by 2015.[2]

As Michigan approaches meeting the RPS set forth in PA 295,[3] policymakers must consider the future of the state's energy policy.[4] This study begins to quantify the economic impact resulting from potential changes to the state's RPS, which Michigan may examine for future development of wind, solar, biogas, biomass, and hydroelectric resources. This analysis focuses on the construction, operation, and maintenance activities of renewable energy capacity development, but does not include pre-construction activities or ancillary impacts including social or environmental externalities.

Input-output analysis was used to estimate the economic impact of investment in renewable energy capacity in Michigan. Changes in energy demand and estimates of supply from renewable sources are used to calculate direct, indirect, and induced economic impacts including total economic output, job-years supported, and employee compensation.

Michigan can meet increases in its RPS by investing at varying levels in wind, solar, biogas, biomass, and other renewable energy sources. For this study, growth within each technology is correlated to the current investments being made within Michigan, based on renewable energy projects approved through 2014.

Given projections of growth in energy demand and scenarios increasing the state's RPS, analysis of the 15 percent by 2020 scenario indicates that the selected activities as a whole could have a potential gross impact of $3.28 billion on Michigan, including more than 20,000 job-years supported and $1.06 billion in employee compensation. The summary of gross impacts for the 20 percent by 2025 scenario shows a total output of $6.57 billion, more than 41,000 job-years supported and $2.11 billion in employee compensation. Scenarios were developed within a ten-year timeline based on data reliability and availability.

While environmental benefits often dominate energy policy dialogue, this study presents evidence of economic impact which should be considered in the context of likely return on investment. Study results are not intended to advocate for or against any particular policy, strategy, or investment, but rather serve as an assessment of the impacts a set of investments may have on Michigan's economy. Equipped with this analysis and others, policymakers will be better informed to make decisions regarding the state's energy future, including investments in renewable and nonrenewable capacity and long-term strategies to advance Michigan's energy economy.

[1] Michigan Legislature, 2008
[2] Ibid.
[3] Michigan Department of Licensing and Regulatory Affairs, 2013a
[4] Michigan Department of Licensing and Regulatory Affairs, 2013b

INTRODUCTION

Michigan's Public Act 295 (PA 295) of 2008 requires electric providers to generate 10 percent of electricity sales from renewable energy sources by 2015.[5] "A renewable portfolio standard (RPS) is a regulatory requirement to increase production of energy from renewable sources such as wind, solar, biomass and other alternatives to fossil fuel and nuclear electric generation.[6]" Marking a national trend, 29 states, Washington DC, and two territories currently have renewable energy standards.[7] Additionally, eight states and two territories have established renewable energy goals.[8]

As Michigan approaches meeting the RPS set forth in PA 295,[9] policymakers must consider the future of the state's energy policy.[10] This study, *Economic Impact of Two Renewable Portfolio Standard Scenarios in Michigan, 2015 to 2025,* begins to quantify the economic impact resulting from potential changes to the state's RPS which Michigan may examine for future state policy decisions. The two scenarios analyzed are 15 percent RPS by 2020 and 20 percent RPS by 2025. Scenarios were developed within a ten-year timeline based on data reliability and availability.

RPS scenarios have been previously analyzed by other researchers to understand impacts related to potential policy changes. Each study has provided stakeholders with new perspectives of the opportunities and challenges Michigan faces in making decisions regarding energy policy. This study quantifies specific RPS scenarios in the context of gross job-years and economic output impacts within Michigan and provides an additional data point to enhance decision making.

Michigan can meet increases to the RPS by investing at varying levels in renewable energy technologies. This study adopts current investment trends in wind, solar, biomass, and landfill gas renewable technologies to forecast increased capacity within each scenario. This subset of technologies was selected based upon current activity and preliminary thoughts on future investment choices of public and private sector stakeholders.

This study is meant to inform state-level conversations already occurring within Michigan by providing objective evidence that renewable energy capacity development can create a direct, indirect, and induced economic effect on the state. It is not intended to exclusively promote nor deter any particular policy, strategy, or investment in renewable energy capacity.

5 Michigan Legislature, 2008
6 National Renewable Energy Laboratory, 2014
7 Michigan Department of Licensing and Regulatory Affairs, 2013a
8 Ibid.
9 Ibid.
10 Michigan Department of Licensing and Regulatory Affairs, 2013b

This study uses input-output analysis to assess the economic impact of renewable energy construction and generation activities on Michigan's economy. The Jobs and Economic Development Impact (JEDI) model developed by the National Renewable Energy Laboratory (NREL) and the Minnesota IMPLAN Group's IMPLAN models were used to estimate the regional impact of construction, operation, and maintenance activities associated with renewable and nonrenewable energy sources.

Construction activities include contractors and subcontractors directly engaged in construction tasks (i.e. carpenters, electricians, welders, laborers, equipment operators) and related administrative staff (i.e. purchasing, accounting, personnel). Operations and maintenance activities include the contractors and subcontractors directly engaged in operation and maintenance tasks (i.e. electricians, mechanics, and equipment operators) and related administrative staff (i.e. purchasing, accounting, personnel). Direct, indirect, and induced economic impacts from construction, operation, and maintenance activities are combined to estimate total economic impact.

Input-output economic impact modeling calculates the direct, indirect, and induced economic impact on a regional economy based on a shift in economic activity such as increased construction of renewable energy capacity as a result of a shift in final demand. The model developed for this study calculates impact based on:

- Forecasted changes in demand for renewable energy capacity by 2020 and 2025
- Estimates of costs for the construction of renewable energy capacity
- Estimates of costs for the operation and maintenance of renewable energy capacity
- Estimates of sector-to-sector trade based on IMPLAN software and data

This information is essential to the development of an input-output economic impact model and for the analysis of direct, indirect, and induced impacts. Modeled scenarios are an illustration of potential energy policies and portfolios Michigan may pursue. This study only considers the construction, operation, and maintenance of capacity built to meet increases in the RPS. It does not consider pre-construction activities or ancillary impacts like social or environmental externalities.

CURRENT STATE OF RPS IN MICHIGAN

Michigan has a long history of supporting renewable energy and pursuing energy efficiency, including early investment in biomass power plants, hydroelectric dams, solar energy systems, and wind turbines.[11] [12] While these efforts are noteworthy, Michigan has historically generated a majority of its energy from nonrenewable energy sources. Michigan's limited nonrenewable energy resources, in the form of coal, natural gas, nuclear, and petroleum, require the state to import a majority its energy from other states and countries.[13]

To promote increased investment in renewable energy and capitalize on the renewable resources found within the state, Michigan adopted PA 295 of 2008.[14] According to Michigan compiled law, this act is intended to:

> *"…promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following:*
>
> > *(a) Diversify the resources used to reliably meet the energy needs of consumers in this state.*
> >
> > *(b) Provide greater energy security through the use of indigenous energy resources available within the state.*
> >
> > *(c) Encourage private investment in renewable energy and energy efficiency.*
> >
> > *(d) Provide improved air quality and other benefits to energy consumers and citizens of this state."*[15]

PA 295 requires electric providers to deliver 10 percent of their electricity sales from renewable energy sources by 2015. To achieve this requirement, providers are required to either purchase renewable energy, purchase renewable energy capacity, build renewable energy capacity, or purchase renewable energy credits (RECs).[16]

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[11] American Council for Energy-Efficient Economy, 2013
[12] Michigan Energy Options, 2009
[13] Michigan Department of Licensing and Regulatory Affairs, 2011
[14] Ibid.
[15] Michigan Legislature, 2008
[16] Ibid.

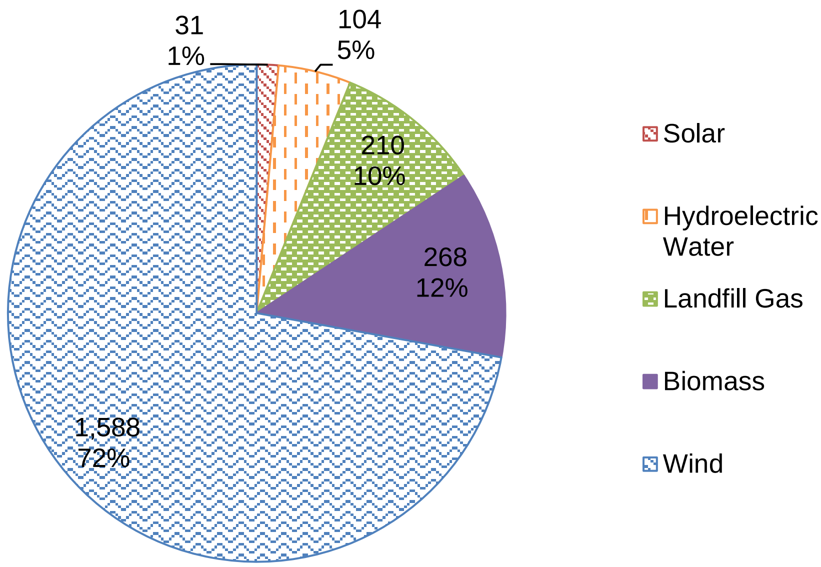
Since 2008, Michigan has invested in its renewable energy infrastructure and generation capacity creating over 1,400 megawatts (MW) of new renewable energy capacity.[17] Providers anticipate that by 2015 the operational renewable energy capacity within Michigan will be 1,650 MW.[18] A majority of the renewable energy investment will be in wind, with over 1,100 MW of capacity developed since 2008. Table 1 shows the growth in capacity and the growth for each technology as a percentage of the total increase in capacity since 2008.

Table 1. Technology Capacity Projects Approved from 2008 to 2014[19]

Technology	Capacity (MW)	Percent of Total Capacity Growth
Wind	1,211	90.75%
Landfill Gas	55	4.13%
Biomass	53	3.97%
Solar	14	1.02%
Hydroelectric Water	2	0.13%
Total	**1,334**	**100.00%**

Current total capital investments in renewable energy within Michigan are over $2 billion and are expected to reach $3.5 billion by 2015.[20] This investment in renewable energy has increased Michigan's energy independence and provided capacity to meet the state's increasing energy demands and the generation requirements of PA 295. Figure 1 provides Michigan's 2015 projected total renewable energy capacity by source based on the base capacity in 2008[21] and built capacity approved through 2014.[22]

Figure 1. Projected Total Renewable Energy MW Capacity by Source, 2015



[17] Michigan Department of Licensing and Regulatory Affairs, 2013
[18] Consumers Energy, DTE Energy, and MEGA, 2013
[19] Michigan Renewable Energy Certification System (MIRECS), 2014
[20] Consumers Energy, DTE Energy, and MEGA, 2013
[21] United States Energy Information Agency, 2013
[22] Michigan Renewable Energy Certification System (MIRECS), 2014

FUTURE RPS SCENARIOS IN MICHIGAN

As Michigan approaches 2015 and meets the RPS set forth in PA 295, policymakers must consider the future of the state's energy policy. To this end, the economic impacts of various RPS scenarios and changes to Michigan's energy policy have been estimated prior to this study.[23] [24] [25] The purpose of this study is to be a resource for policymakers by adding depth and breadth to the discussion through quantifying the economic impact resulting from two potential scenarios which modify Michigan's RPS.

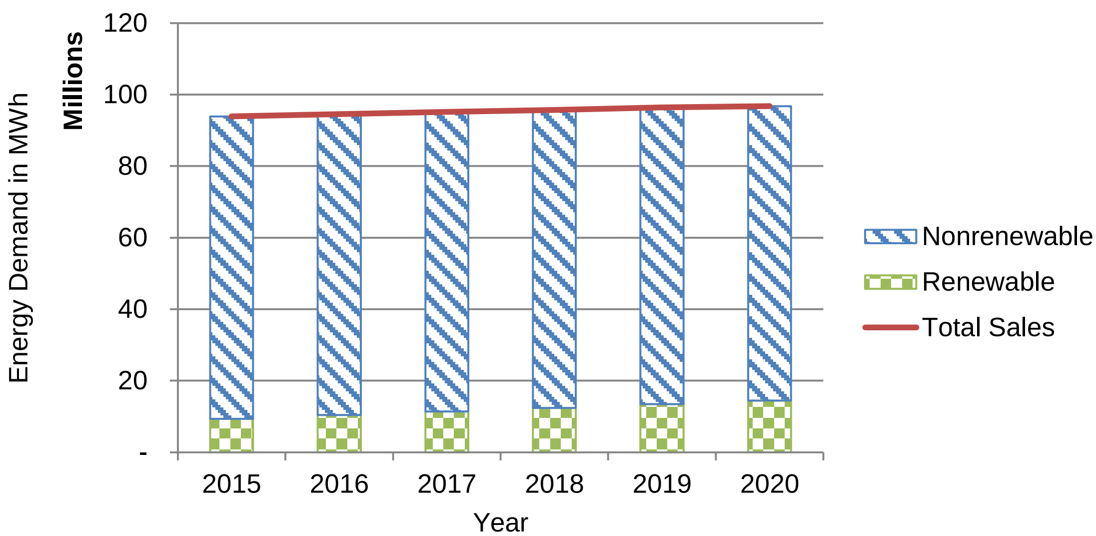
The two scenarios analyzed are a 15 percent RPS by 2020 and a 20 percent RPS by 2025. Specifically, this report focuses on the employment and economic output impacts an increase in Michigan's RPS would have on the state.

Scenario 1: 15 Percent by 2020

Scenario 1 estimates the impacts of requiring electric providers to generate at least 15 percent of their annual retail sales of electricity from renewable energy sources by 2020. Eligible renewable energy sources include wind, solar, biomass, geothermal, hydroelectric, hydrothermal, and landfill gas.

Michigan's energy demand is anticipated to grow from 93.98 million megawatt hours (MWh) to 96.75 million MWh between 2015 and 2020, a three percent growth in demand (see Appendix B). To meet this growth in demand and increases in the RPS, Michigan would need the capacity to produce 14.51 million MWh of electricity from renewable energy by 2020. Figure 2 shows Michigan's energy portfolio increasing from 10 percent in 2015 to 15 percent in 2020 and remaining at this level of generation until 2025.

Figure 2. Michigan Energy Portfolio for 15 Percent by 2020[26]



[23] Kulesia, S. et.al., 2007
[24] Tuerck, D. et.al., 2012
[25] Calin, B. et.al., 2012
[26] United States Energy Information Agency, 2013

Michigan can meet the increase in renewable energy demand by investing at varying levels in wind, solar, biomass, landfill gas, and hydroelectric technologies. Growth within each technology is correlated to current investments in Michigan based on renewable energy projects approved through 2014 (see Table 1). Due to current regulations and the environmental impacts of developing dams, this study assumes that hydroelectric water power capacity will not grow in Michigan through 2025.

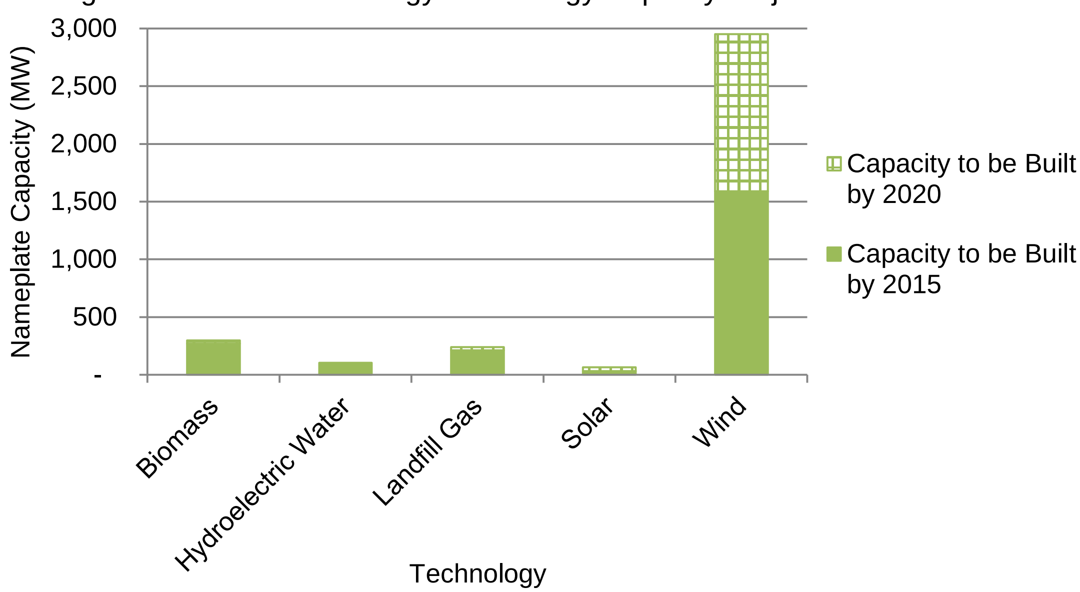
In order to meet the renewable energy demands of 15 percent by 2020 Michigan would need to build additional capacity totaling 1,449 MW. Wind is anticipated to grow by 1,361 MW, solar installations would grow by 32 MW; biomass capacity would grow by 28 MW; and landfill gas capacity would increase by 29 MW. Table 2 provides the total operational capacity by generation source to achieve 15 percent by 2020.

Table 2. Total Renewable Energy Capacity Nameplate for 15 Percent by 2020

Technology	Nameplate (MW)
Wind	2,949
Biomass	296
Landfill Gas	239
Hydroelectric Water	104
Solar	63
Total	**3,651**

Building upon the capacity developed to meet the PA 295 RPS of 10 percent by 2015, Figure 3 shows the projected increased capacity by source necessary to meet the Scenario 1 RPS of 15 percent by 2020. This increased capacity requires construction of 680 utility wind turbines, installation of 2,022 solar systems, construction and development of a new biomass power plant, and the building of six landfill gas collection systems.

Figure 3. Renewable Energy Technology Capacity Projections to 2020



	Biomass	Hydroelectric Water	Landfill Gas	Solar	Wind
Capacity to be Built by 2020	296	104	239	63	2,949
Capacity to be Built by 2015	268	104	210	31	1,588

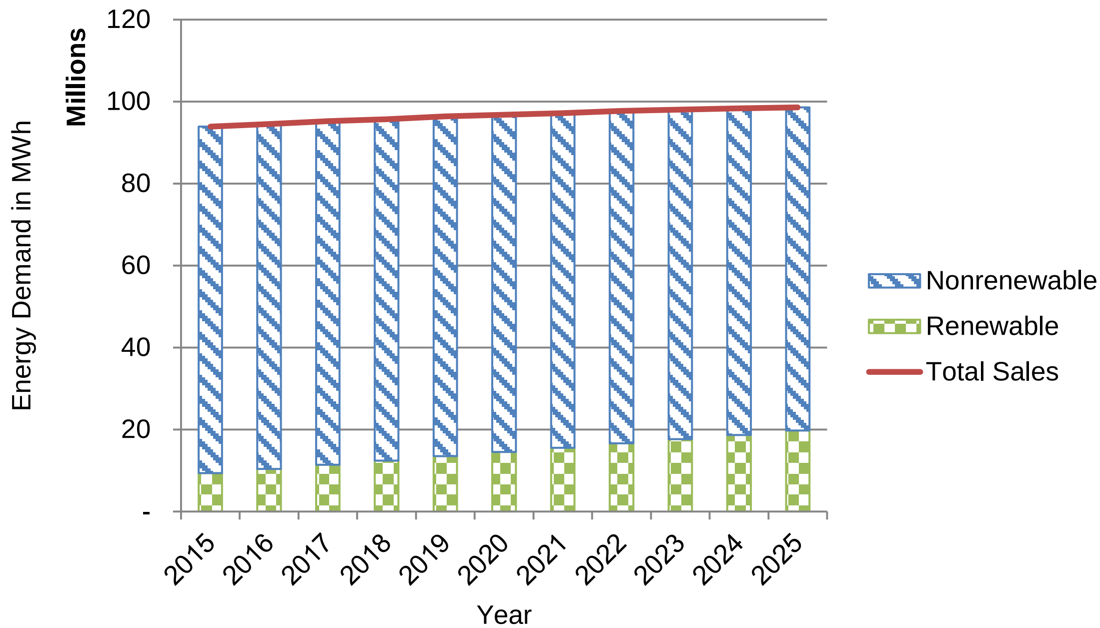
In addition to construction of capacity, the operation and maintenance associated with the increased renewable energy capacity would impact Michigan's economy. The impacts from the operation and maintenance would support employment and economic output for the lifetime of the built capacity. Wind turbines, solar systems, and biomass power plants have a life expectancy of 20 years. Landfill gas collection systems are expected to generate electricity for 30 years, which is the life expectancy of the system.

Scenario 2: 20 Percent by 2025

Scenario 2 estimates the impact of requiring electric providers to deliver at least 20 percent of their annual retail sales of electricity from renewable energy sources by 2025. Eligible renewable energy sources include wind, solar, biomass, landfill gas, geothermal, hydrothermal, and hydroelectric.

By 2025, Michigan's energy demand is anticipated to grow to 98.57 million MWh, a five percent increase from 2015 estimates of 93.89 million MWh. To meet this growth in demand and increases to the RPS, Michigan would need the capacity to produce 19.71 million MWh of electricity from renewable sources by 2025. Figure 4 shows Michigan's energy portfolio increasing from 10 percent in 2015 to 20 percent in 2025.

Figure 4. Michigan Energy Portfolio for 20 Percent by 2025



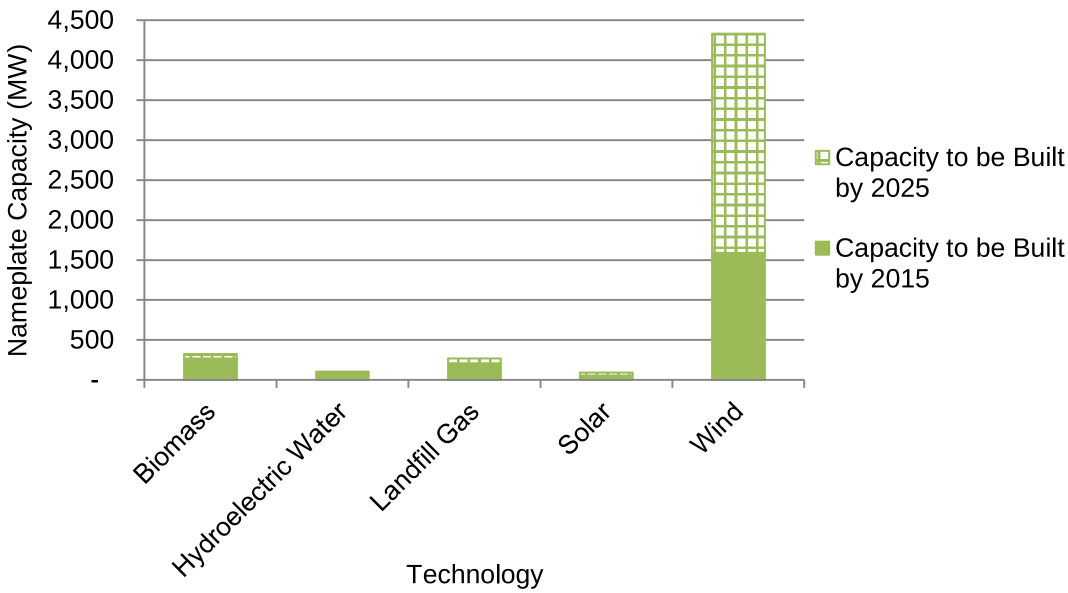
Michigan would need to build additional capacity to meet the renewable energy demands of 20 percent by 2025, totaling 2,921 MW. Growth within each technology is correlated to current investments in Michigan based on renewable energy projects approved through 2014. Wind would increase by 2,743 MW, solar installations would grow by 65 MW, biomass capacity is anticipated to grow by 56 MW; and landfill gas capacity would increase by 59 MW. Table 3 provides the total operational nameplate capacity by generation source to achieve 20 percent by 2025.

Table 3. Renewable Energy Capacity Nameplate for 20 Percent by 2025

Technology	Nameplate (MW)
Wind	4,331
Biomass	324
Landfill Gas	269
Hydroelectric Water	104
Solar	95
Total	**5,123**

Figure 5 shows the projected increased capacity by source necessary to meet Scenario 2 requirements. This increased capacity would require construction of 1,370 utility wind turbines, installation of 4,076 solar systems, construction and development of two new biomass power plants, and the building of 13 landfill gas collection systems.

Figure 5. Renewable Energy Technology Capacity Projections to 2025



	Biomass	Hydroelectric Water	Landfill Gas	Solar	Wind
Capacity to be Built by 2025	324	104	269	95	4,331
Capacity to be Built by 2015	268	104	210	31	1,588

The continued operation and maintenance associated with the increased renewable energy capacity would impact Michigan's economy. The impacts from the operation and maintenance would support employment and economic output for the lifetime of the built capacity.

ECONOMIC IMPACT FINDINGS

Overview of Model

The economic impact of the construction, operation, and maintenance activities related to Michigan's renewable energy capacity were estimated using JEDI and IMPLAN to quantify direct, indirect, and induced economic effects.

NREL developed the JEDI models to estimate the regional impact of construction, operation, and maintenance associated with renewable and nonrenewable energy sources. Model defaults are based upon interviews with industry experts and project developers. Economic multipliers contained within the model are derived from IMPLAN software. [27]

IMPLAN is a software and data package that enables development of input-output economic impact models for a particular geography or study area. Michigan state-level data for the year 2011 (the most recent data available) are used to build the model for this study. The models are developed to quantify the direct, indirect, and induced economic impacts based on spending changes in defined industries.

> **Direct** economic impact includes changes in production that result from final demand changes. In this case, direct impact may include increases in spending that result from additional purchases related to the construction, operation, and maintenance of wind turbines, solar panels, biomass conversion devices, or landfill gas devices within the scope of this study.
>
> **Indirect** economic impact includes changes in production of inputs resulting from changes in demand for a final product. In this case, indirect impact may include new purchases of steel and plastics by firms producing in-demand wind turbines or other renewable energy devices within this study scope.
>
> **Induced** economic impact includes the changes in household spending patterns as a result of altered household income from direct and indirect impacts. In this case, induced impact may include increased spending by individuals employed by steel, plastic, and wind turbine manufacturing companies or other supply chain component or final product manufacturers within the study scope.
>
> **Total** economic impact is the sum of direct, indirect, and induced economic impacts for the renewable energy construction, operation, and maintenance activities included in the scope of this study.

[27] National Renewable Energy Laboratory, 2013

Results

Capacity projection and energy demand estimates were analyzed by the JEDI and IMPLAN models for their direct, indirect, and induced impacts. Results were computed for the two demand scenarios on projected job-years supported, labor income, and total output.

Employment (Job-years Supported) is the total number of jobs supported by the estimated construction, operations, and maintenance activities. The jobs supported refer to one job-year (2,080 hours). The actual headcount of jobs will vary depending on the intensity and duration of jobs.[28]

Labor Income is the sum total of all forms of employment income, including employee compensation (wages and benefits) and proprietor income.[29]

Output represents the total value of industry production. In IMPLAN, these are annual production estimates for the year of the data set and are in producer prices. For service providers, production is equal to sales.[30]

Summary of Impacts

Scenario summaries show the potential impact of increased renewable energy capacity development on Michigan economy. Analysis of the 15 percent by 2020 scenario indicates that selected activities as a whole have the potential to create a total impact of $3.28 billion on Michigan's economy, including more than 20,000 job-years supported and $1.06 billion in employee compensation. Table 4 provides direct, indirect, and induced impacts for Scenario 1.

Table 4. Summary of Impacts for Scenario 1 – 15 Percent by 2020 Impacts (in 2014 dollars)

Impacts	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction			
Direct	1,700.4	$ 104.48	$ 184.81
Indirect	4,749.0	$ 267.70	$ 758.36
Induced	1,978.0	$ 88.53	$ 279.41
Operation and Maintenance (over lifetime of technology)			
Direct	3,808	$ 219.28	$ 296.51
Indirect	4,012	$ 177.40	$ 1,142.70
Induced	4,356	$ 203.34	$ 622.11
Total	20,603	$ 1,060.74	$ 3,283.89

[28] Minnesota IMPLAN Group, 2013
[29] Ibid.
[30] Ibid.

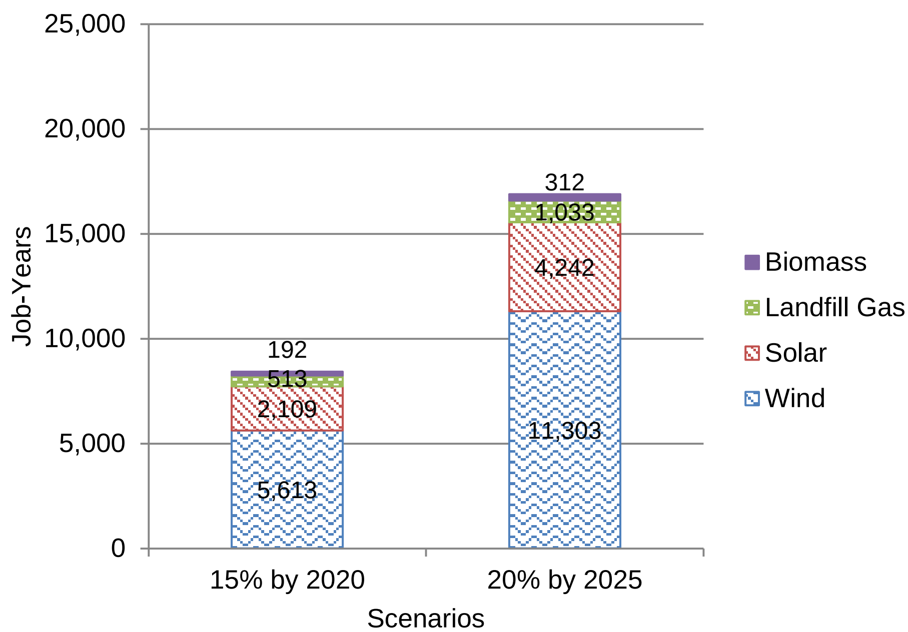
The summary of impacts for the 20 percent RPS by 2025 scenario shows a total output of $6.57 billion, including more than 41,000 job-years supported and $2.11 billion in employee compensation. Table 5 provides direct, indirect, and induced impacts for Scenario 2.

Table 5. Summary of Impacts for Scenario 2 – 20 Percent by 2025 Impacts (in 2014 dollars)

Impacts	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction			
Direct	3,381.5	$ 206.09	$ 367.17
Indirect	9,550.3	$ 538.56	$ 1,526.08
Induced	3,958.6	$ 177.31	$ 559.66
Operation and Maintenance (over lifetime of technology)			
Direct	7,361.0	$ 426.25	$ 581.80
Indirect	8,014.0	$ 353.17	$ 2,288.46
Induced	8,741.0	$ 407.36	$ 1,244.31
Total	41,006.4	$ 2,108.74	$ 6,567.47

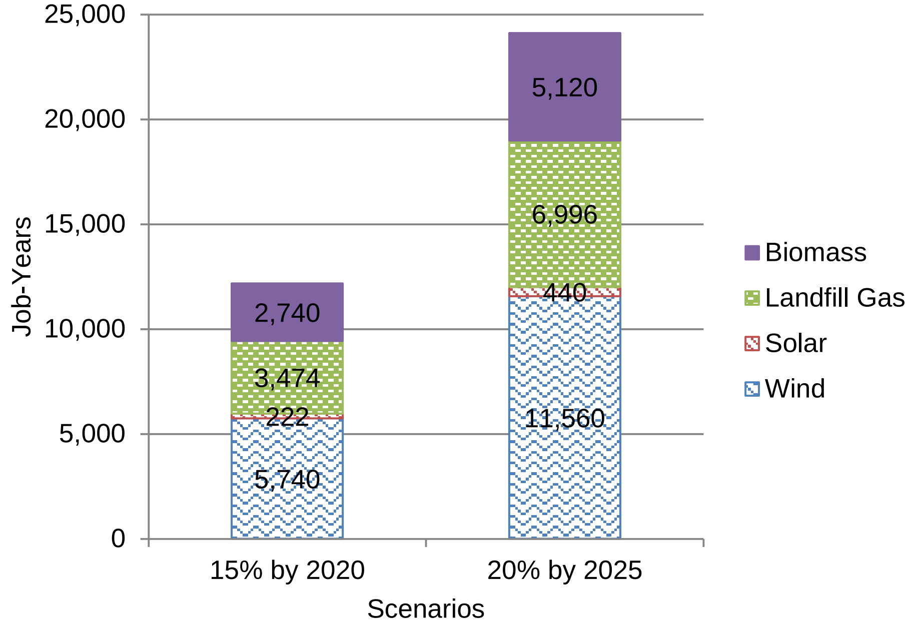
During the construction and installation phase of renewable energy development an estimated 8,427 and 16,890 job-years would be supported in achieving the 15 percent and 20 percent RPS scenarios, respectively. Results are cumulative gross job-years and economic impact estimates from the construction and installation of increased renewable energy capacity by 2020 and 2025. Figure 6 shows the construction job-years supported by increases in renewable energy capacity.

Figure 6. Job-Years Supported by Construction Activities



Operation and maintenance over the lifetime of the renewable energy sources has a greater impact on the total job-years supported within Michigan than construction and installation. Scenario 1 will support 12,176 job-years while Scenario 2 will support 24,116 job-years. Gross job and economic impact estimates from operation and maintenance activities due to increases in renewable energy capacity are cumulative over the lifetime of the technology. Figure 7 shows the operation and maintenance job-years supported by increases in renewable energy capacity.

Figure 7. Job-Years Supported by Operation and Maintenance Activities



CONCLUSION

The conversation on renewable energy development is most often in the context of environmental stewardship. While this conversation is important and worthwhile, it often fails to acknowledge the economic impacts that can arise from investments in renewable energy. As this and other studies have shown, there are benefits derived from the construction and generation activities associated with renewable energy.

In Michigan, there are opportunities to leverage the current momentum related to the implementation of PA 295. Further development of the state's renewable energy can reduce the state's dependence on imported energy and increase economic vitality by supporting jobs for Michigan's workforce and creating value added output for its strong industrial supply chain.

Input-output economic impact analysis of the two potential RPS scenarios indicates that the associated construction, operation, and maintenance activities could positively impact Michigan. Scenario 1, which requires a 15 percent RPS by 2020, could result in $3.28 billion in total output, including 20,000 job-years supported and $1.06 billion in employment compensation. Scenario 2, a 20 percent RPS by 2025, would impact Michigan through $6.57 billion of total output, including 41,000 job-years supported and $2.11 billion in employment compensation. These results are gross impacts of the economic activity resulting from the modeled scenarios.

These results are not intended to advocate for or against any particular policy, strategy, or investment, but rather serve as an assessment of the impacts that a set of investments may have on Michigan's economy. Michigan can meet increases to the RPS by investing at varying levels in renewable energy technologies.

As policy makers, industry leaders, and other stakeholders begin to understand the economic impact of increased investment in Michigan's renewable energy resources and plan for the future of Michigan's economy, the following are potential considerations:

1. A state-level strategy for renewable energy capacity development and state policy changes should be developed in the context of likely return on investment for Michigan's economy.
2. Investments in energy efficiency at a state level, combined with the development of additional renewable energy sources, may exponentially decrease Michigan's dependence on imported energy and increase local and regional economic investment.
3. As Michigan transitions away from nonrenewable sources and toward renewable sources of energy, there may be a temporary displacement of workers. A long-term energy transition plan may help to mitigate this impact.
4. Impacts on Michigan's economy may increase if Michigan businesses are able to meet the increased activity from the construction, operation, and maintenance of renewable energy sources to a degree higher than modeled. Efforts to encourage use of local supply chains may help attract new investment from out-of-state firms and increase efficiencies in capacity development.

REFERENCES

"American Council for Energy-Efficient Economy." State Energy Efficiency Policy Database, 2013, http://aceee.org/sector/state-policy/michigan

Anders, Melissa. "Michigan Proposal 3: Voters Reject 25 by 25 Renewable Energy Mandate." MLIVE, November 2012. http://www.mlive.com/politics/index.ssf/2012/11/proposal_3_michgians_renewable.html

Calnin, Benjamin, Charles McKeown, and Steven Miller. "Projected Job and Investment Impacts of Policy Requiring 25% Renewable Energy by 2025 in Michigan." Michigan State University and Michigan Environmental Council. April 2012. http://www.environmentalcouncil.org/mecReports/MSU_Jobs_Report_25x25.pdf

Consumer Energy, DTE Energy, and MEGA. Joint Responses to Energy Efficiency Questions, 2013. https://www.michigan.gov/documents/engergy/reenewables_energy_question_1_response_f_rom_DTE_Consumers_and_MEGA_419430_7.pdf

English, Burton, Kim Jenson, Jamey Menard, and Daniel De La Torre Ugarte. Projected Impacts of Federal Renewable Energy Portfolio Standards on the North Carolina Economy. Bipartisan Policy Center. August 2009.

Kulesia, Steve, Richard Polich, Jeff Amlin, Randy Levesque, and Andy Winkelman. A Study of Economic Impacts from the Implementation of a Renewable Portfolio Standard and Energy Efficiency Program in Michigan. NextEnergy Center. April 2007.

Laviolette, Brian. "Volt Plant to Shut for Retooling, Allowing Expanded Production." The Detroit Bureau, June 2011. http://www.thedetroitbureau.com/2011/06/volt-plant-to-shut-for-retooling-allowing-expanded-production/

Lopez, Anthony, Billy Roberts, Donna Heimiller, Nate Blair, and Gian Porro. U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis, National Renewable Energy Laboratory. 2012. http://www.nrel.gov/docs/fy12osti/51946.pdf

Michigan Department of Licensing and Regulatory Affairs. Michigan Energy Overview, State of Michigan. October 2011. http://www.dleg.state.mi.us/mpsc/reports/energy/energyoverview/

Michigan Department of Licensing and Regulatory Affairs. 2013 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs. November 2013a. http://michigan.gov/documents/mpsc/eo_report_441092_7.pdf

Michigan Department of Licensing and Regulatory Affairs. Readying Michigan to Make Good Energy Decisions: Renewable Energy. November 2013b. https://www.michigan.gov/documents/energy/renewable_final_438952_7.pdf

Michigan Energy Options, Michigan Renewable Energy Success Stories, 2009. http://michiganenergyoptions.org/education/226-3-michigan-renewable-energy-success-stories

Michigan Legislature, Public Act 295 of 2008. http://www.legislature.mi.gov/(S(dqajqg45mi45dqiadzepzw55))/mileg.aspx?page=getobject&objectName=mcl-act-295-of-2008

Michigan Renewable Energy Certification System (MIRECS), MIRECS Projects, 2014. http://www.mirecs.org/

Minnesota IMPLAN Group. “Economic Impact Modeling.” MIG, Inc., August 2013.

National Renewable Energy Laboratory, JEDI Model. 2013. http://www.nrel.gov/analysis/jedi/

National Renewable Energy Laboratory, State and Local Activities. 2014. http://www.nrel.gov/tech_deployment/state_local_activities/basics_portfolio_standards.html

Transparent Cost Database, “Capacity Factor.” 2012. http://en.openei.org/apps/TCDB/

Tuerck, David, Paul Bachman, and Michael Head. The Projected Economic Impact of Proposal 3 and Michigan’s Renewable Energy Standard. Mackinac Center for Public Policy. September 2012.

United States Department of Energy. Energy Information Administration. Annual Energy Outlook 2013. http://www.eia.gov/forecasts/aeo/

APPENDIX A: RESEARCH LIMITATIONS

The following are additional considerations to be consulted while reviewing the results of this study.

- Data used for this report is cited from current, reliable sources. When conflicts in data arose, the most conservative estimates were utilized to avoid overestimation.

- Averaging and using linear projections in the modeling of renewable energy capacity development may skew specific yearly forecasts; however, the average values are critical to assessing economic impact in an efficient manner.

- The study relies heavily on secondary data since a lack of primary data was available to researchers. Assumptions made by researchers in the development of source data are reflected in the results of this study.

- Import and export figures for the State of Michigan are calculated by the JEDI and IMPLAN model. JEDI and IMPLAN's default values and percentages were used to quantify the Michigan trade flows. Modification of the IMPLAN industry margins, ratios, and percentages may allow for the creation of a more exact model should primary data become available. Impacts on Michigan's economy may increase if firms within the state are able to meet the increased activity from the construction, operation, and maintenance of renewable energy sources to a degree higher than modeled.

- This study assumes that hydroelectric water power capacity will not grow in Michigan based on current regulations and the environmental impacts associated with dam development.

- In calculations, researchers set aside the Renewable Energy Credits (RECs) and estimated the economic impact on the state as if the RPS standard will be fully met by renewable energy capacity built within Michigan.

- Growth in each technology is projected based upon past investments within Michigan. The study does not account for new technologies or improvements in technologies that may emerge through 2025.

- Researchers originally intended to model impacts of policy changes to Michigan's Energy Optimization Program (EOP) in conjunction with modifications to the state's RPS but data is currently unavailable. The EOP report is forthcoming and will serve as an addendum to the RPS report.

APPENDIX B: MICHIGAN ENERGY DEMAND

To understand the economic impact of changes to state policies related to energy, projections of electricity sales within Michigan were assessed to identify demand. This study utilizes the United States Energy Information Administration's *Annual Energy Outlook 2013* projections for the Reliability First Corporation – Michigan.[31] This market module includes the lower peninsula of Michigan and historically constitutes 90 percent of the energy demand in the state.[32] The upper peninsula of Michigan is included in a Reliability First Corporation-West and is not included in this analysis. Forecasts for the upper peninsula were not available disaggregated from the Reliability First Corporation – West which includes Illinois, Kentucky, Maryland, Ohio, Pennsylvania, Virginia, West Virginia, and Wisconsin.

Energy demand estimates refer to the direct purchases of electricity by the end-use consumer. Demand within Michigan is estimated to grow from 2015 to 2025 by 2.3 million MWh in generation and 4.6 million MWh in sales annually. Table 6 provides year-to-year estimates of Michigan's energy demand.

Table 6. Michigan Energy Demand through 2025[33]

Year	Energy Demand (MWh)
2015	93,890,205
2016	94,514,755
2017	95,191,933
2018	95,700,645
2019	96,399,872
2020	96,746,590
2021	97,194,687
2022	97,722,977
2023	98,026,611
2024	98,310,570
2025	98,573,456

Projections of energy demand do not include impacts from changes to the energy optimization program. Increases or decreases to the current energy optimization program may positively or negatively impact Michigan energy demand.

[31] United States Energy Information Administration, *Annual Energy Outlook 2013*, 2013
[32] Ibid.
[33] Ibid.

APPENDIX C: CAPACITY FACTOR

The capacity factor of renewable energy sources is the ratio of actual output to nameplate capacity. Scenarios were developed by calculating the installed capacity necessary to meet renewable energy demand given technology specific capacity factors.

Equation 1. Capacity Equation

$$Technology\ Capacity = \frac{(Demand) * (Technology\ Marketshare)}{(Time) * (Technology\ Capacity\ Factor)}$$

Advances in technology resulting in improvements to capacity factor would modify the renewable energy capacity that Michigan would need to build to meet generation standards associated with each scenario.

Table 7. Renewable Energy Technology Capacity Factor[34]

Technology	Capacity Factor
Biomass	84.04
Landfill Gas	83.00
Hydroelectric Water	45.00
Wind	39.00
Solar, Photovoltaic - Track	21.60
Solar, Photovoltaic - Fixed	16.00

[34] Transparent Cost Database, *Capacity Factor,* 2012

APPENDIX D: SOURCE IMPACTS

Each renewable energy source and related technology will impact Michigan's economy uniquely depending on the local and regional supply chains and related economic multipliers. Below is the disaggregated impact of each renewable energy source.

Biomass

Table 8. Impacts of Biomass Development in Michigan (in 2014 dollars)

Impacts	2020			2025		
	Job-Years	Earnings (in Millions$)	Output (in Millions$)	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction						
Project Development and Onsite Labor Impacts						
Construction Labor	81.0	$ 8.70	$ 8.70	131.0	$ 14.10	$ 14.10
Construction Related Services	24.0	$ 2.20	$ 3.70	40.0	$ 3.60	$ 6.10
Direct Impact Subtotal	105.0	$ 10.90	$ 12.50	171.0	$ 17.70	$ 20.20
Equipment and Supply Chain Impacts	29.0	$ 1.70	$ 4.50	47.0	$ 2.70	$ 7.30
Induced Impacts	58.0	$ 2.60	$ 7.70	94.0	$ 4.20	$ 12.50
Total Impacts	**192.0**	**$ 15.20**	**$ 24.70**	**312.0**	**$ 24.70**	**$ 40.00**
Operation and Maintenance (over lifetime of technology)						
Onsite Labor Impacts	400.0	$ 18.00	$ 18.00	520.0	$ 22.0	$ 22.0
Local Revenue and Supply Chain Impacts						
Agricultural/Forestry Sector Only	1,600.0	$ 42.00	$ 202.00	3,200.0	$ 84.0	$ 404.0
Other Industries	260.0	$ 18.00	$ 60.00	480.0	$ 34.0	$ 110.0
Indirect Impact Subtotal	1,860.0	$ 60.00	$ 262.00	3,680.0	$ 116.0	$ 514.0
Induced Impact Subtotal	480.0	$ 24.00	$ 70.00	920.0	$ 44.0	$ 132.0
Total Impacts	**2,740.0**	**$ 102.00**	**$ 350.00**	**5,120.0**	**$ 182.0**	**$ 668.0**

Landfill Gas

Table 9. Impacts of Landfill Gas Development in Michigan (in 2014 dollars)

Impacts	2020			2025		
	Job-Years	Earnings (in Millions$)	Output (in Millions$)	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction						
Direct Impacts	206.1	$ 13.67	$ 54.21	415.2	$ 27.53	$ 109.19
Indirect Impacts	136.4	$ 8.69	$ 26.00	274.7	$ 17.50	$ 52.38
Induced Impacts	170.6	$ 7.16	$ 21.71	343.6	$ 14.42	$ 43.72
Total Impacts	**513.1**	**$ 29.52**	**$ 101.92**	**1,033.40**	**$ 59.45**	**$ 205.29**
Operation and Maintenance (over lifetime of technology)						
Direct Impacts	2,034	$ 123.21	$ 200.44	2,034	$ 123.21	$ 200.44
Indirect Impacts	348	$ 18.77	$ 56.22	348	$ 18.77	$ 56.22
Induced Impacts	1,092	$ 45.75	$ 138.67	1,092	$ 45.75	$ 138.67
Total Impacts	**3,474**	**$ 187.74**	**$ 395.33**	**3,474**	**$ 187.74**	**$ 395.33**

Solar

Table 10. Impacts of Solar Development in Michigan (in 2014 dollars)

Impacts	2020			2025		
	Job-Years	Earnings (in Millions$)	Output (in Millions$)	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction						
Project Development and Onsite Labor Impacts						
Construction and Installation Labor	268.1	$ 17.4		539.1	$ 34.9	
Construction and Installation Related Services	448.2	$ 22.7		901.3	$ 45.6	
Direct Impact Subtotal	716.3	$ 40.0	$ 71.2	1,440.3	$ 80.5	$ 143.2
Module and Supply Chain Impacts						
Trade (Wholesale and Retail)	153.3	$ 9.5	$ 27.5	308.3	$ 19.1	$ 55.3
Professional Services	137.4	$ 6.2	$ 20.7	276.5	$ 12.4	$ 41.6
Other Services	191.0	$ 13.6	$ 44.8	384.3	$ 27.5	$ 90.1
Other Sectors	342.7	$ 10.0	$ 20.8	689.3	$ 20.1	$ 41.8
Indirect Impact Subtotal	824.6	$ 39.3	$ 113.8	1,658.6	$ 79.1	$ 228.8
Induced Impact Subtotal	568.4	$ 21.9	$ 74.9	1,143.0	$ 44.0	$ 150.6
Total Impacts	**2,109.3**	**$ 101.2**	**$ 259.8**	**4,241.9**	**$ 203.5**	**$ 522.6**
Operation and Maintenance (over lifetime of technology)						
Onsite Labor Impacts	134.0	$ 8.1	$ 8.1	266.0	$ 16.1	$ 16.1
Indirect Impact Subtotal	44.0	$ 2.6	$ 8.5	92.0	$ 5.4	$ 17.2
Induced Impact Subtotal	44.0	$ 1.6	$ 5.4	82.0	$ 3.2	$ 11.0
Total Impacts	**222.0**	**$ 12.3**	**$ 22.0**	**440.0**	**$ 24.6**	**$ 44.3**

Wind

Table 11. Impacts of Wind Development in Michigan (in 2014 dollars)

Impacts	2020			2025		
	Job-Years	Earnings (in Millions$)	Output (in Millions$)	Job-Years	Earnings (in Millions$)	Output (in Millions$)
Construction						
Project Development and Onsite Labor Impacts						
Construction and Interconnection Labor	593.0	$ 31.70		1,194.0	$ 63.80	
Construction Related Services	80.0	$ 8.20		161.0	$ 16.60	
Direct Impact Subtotal	673.0	$ 39.90	$ 46.90	1,355.0	$ 80.40	$ 94.60
Indirect Impact Subtotal	3,759.0	$ 218.00	$ 614.10	7,570.0	$ 439.30	$ 1,237.60
Induced Impact Subtotal	1,181.0	$ 56.90	$ 175.10	2,378.0	$ 114.70	$ 352.80
Total Impacts	**5,613.0**	**$ 314.80**	**$ 836.10**	**11,303.0**	**$ 634.50**	**$ 1,685.00**
Operation and Maintenance (over lifetime of technology)						
Onsite Labor Impacts	1,240.0	$ 70.00	$ 70.00	2,480.0	$ 140.00	$ 140.00
Local Revenue and Supply Chain Impacts	1,760.0	$ 96.00	$ 816.00	3,540.0	$ 194.00	$ 1,644.00
Induced Impacts	2,740.0	$ 132.00	$ 408.00	5,540.0	$ 268.00	$ 822.00
Total Impacts	**5,740.0**	**$ 298.0**	**$ 1,294.0**	**11,560.0**	**$ 602.00**	**$ 2,608.00**

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