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Readying Michigan to Make Good Energy Decisions

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If you wish to speak today, please complete the following:

Name: Amy Clickner

Affiliation (if any): CEO, Lake Superior Community Partnership

Phone: 226-9658

Email: aclickner@marquette.org

Topics you wish to address today:

a. ___ **Renewable Energy Portfolio Standards**

b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ✓ **Other Additional Energy Topic**

(Please specify): Overall regional infrastructure

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If you wish to speak today, please complete the following:

Name: SEAN BRADY

Affiliation (if any): Wind on the Wires

Phone: 312-867-0609

Email: SBRADY@windonthewires.org

Topics you wish to address today:

a. X **Renewable Energy Portfolio Standards**

b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): _____

Please prioritize and focus your comments to afford as many as possible, the opportunity to speak. The amount of time allowed for each speaker will be dependent upon the number of people requesting to speak. Please prepare for the time limit for each speaker to be in the 2 – 5 minute range.

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Michigan Energy Public Forum – Marquette

Wind Energy Can Meet Michigan's Future Needs

Sean R. Brady
Regional Policy Manager
Wind on the Wires
sbrady@windonthewires.org

wind on the wires™
Bringing Wind Power to Market

Wind Energy Can Meet Michigan's Future Needs

- Michigan Can Meet an Increased RES – From In-State or From Neighboring States

- MISO has excelled at integrating Wind Energy
  - Variability does not mean Unreliable
  - Improvements in the Integration of Wind
  - MISO does not foresee significant operational Issues related to wind over the next several years

Ability to Meet an Increased RES – From Michigan

EXHIBIT 3
Estimated Minimum and Maximum Number of Turbines, Capacity, and Annual Energy Production, by Identified Region

		Minimum			Maximum		
Region	Counties	Number of turbines	Capacity (MW)	Annual energy potential (MWh)	Number of turbines	Capacity (MW)	Annual energy potential (MWh)
1	Allegan	166	249	747,938	296	445	1,338,415
2	Antrim Charlevoix	102	153	439,555	183	274	786,572
3	Benzie Leelanau Manistee	435	652	1,991,679	778	1,167	3,564,058
4	Huron Bay Saginaw Sanilac Tuscola	1,578	2,367	6,723,472	2,824	4,236	12,031,477
TOTAL		2,281	3,421	9,902,644	4,081	6,122	17,720,522

SOURCE: Research and findings from Michigan State University Land Policy Institute, 2009, prepared for WERZ Board.

Sources: Final Report of the Michigan Wind Energy Resource Zone Board at 5; U.S. E.I.A., state electricity profiles – Michigan; NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011)

Total Retail Sales in Michigan (2010):

103,649,219 MWhs

The four wind energy zones in Michigan could potentially produce between 9.5% and 17.1% of Michigan's energy demand and NREL estimates MI has potential to generate up to 150% of demand.

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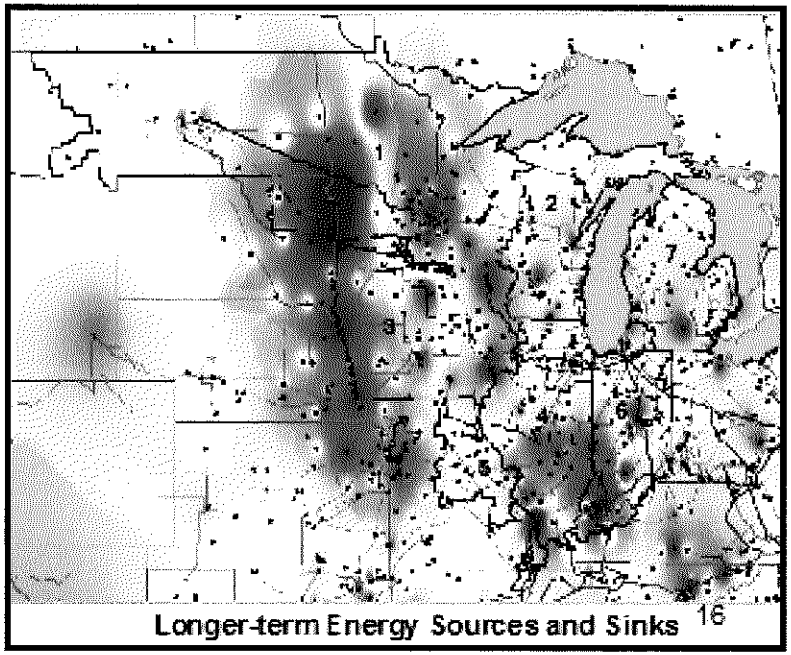
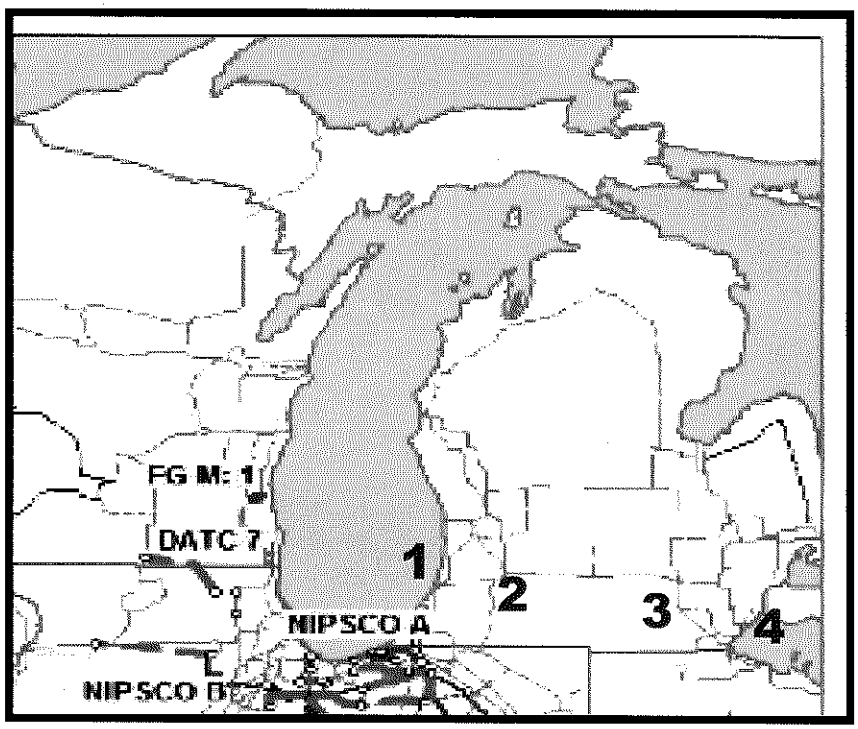
Ability to Meet an Increased RES – From Outside Michigan



Energy Source

Energy Need



345kV Transmission Ties into Michigan

Source: MISO MEP TRG Presentation 2/5/13

Ability to Meet an Increased RES – From Outside Michigan

State	Wind Energy Potential Annual Generation (MWh)
Michigan	169,221,000
Indiana	443,192,000
Ohio	151,881,000
Illinois	763,529,000
Wisconsin	300,136,000
Minnesota	1,679,480,000
Iowa	2,026,340,000
North Dakota	2,983,750,000
South Dakota	3,411,690,000
Missouri	810,619,000
Montana	3,228,620,000
TOTAL:	**15,969,178,000**

If these 11 states produce 0.1% of their potential wind energy, they could provide enough energy to meet a 15% RES requirement in Michigan.

Total Retail Sales in Michigan (2010): 103,649,219 MWhs

Approximate RES Requirement for Michigan: 10,364,922 MWhs

SOURCE: (NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011); ; U.S. E.I.A., state electricity profiles – Michigan

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Reliability of Wind

Variable ≠ Unreliable

Reliability of Wind

Facts About Wind Generation

- Change in wind is slow and predictable
- Methods used to predict wind are improving and will continue to improve
- Change in wind speed is more predictable than changes in electricity supply or demand or a plant outage
- Wind farms have numerous turbines, so you always have some form of production if one goes down – not so with a centralized plant – like coal or gas

Changes at MISO to Integrate Wind since passage of RES in 2008

- Wind facility operators are required to submit day-ahead forecasts
- Implemented Dispatchable Intermittent Resources

The Focus is ➡ Wind Integration

Wind generation has increased ten-fold in five years in MISO

- **Installed wind capacity: 12,270 MW** (Registered March 2013; 9,544 MW registered as DIR in the March 2013 Commercial Model)
- Record wind peak: 10,012 MW (Set 11/23/12; ~25% of gen output at the time)
- **Wind generation: 6.4% of total MISO energy over the last 12 months** (Feb12-Jan13; % of MISO RT load)
- **Congestion is increasing**; MVP lines will help mitigate

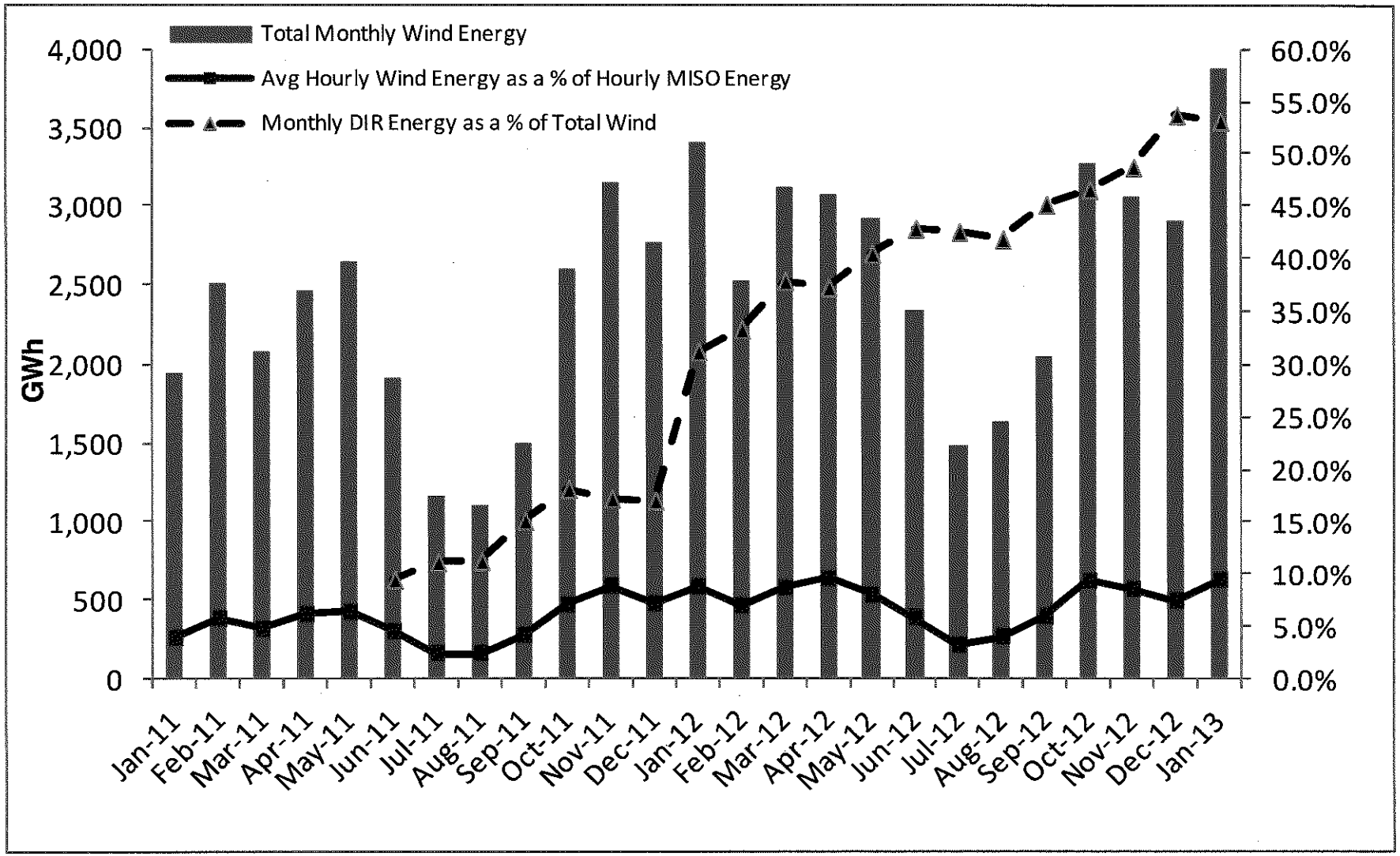
MISO operations has gained significant experience successfully integrating wind

- Wind helps keep prices low for MISO customers and the end-user consumer
- Output variability is being mitigated by geographic diversity
- Wind forecasting has improved and is expected to continue improving
- Wind has had a small impact on regulation reserves

  Contingency reserves have never been deployed due to a drop in wind output
- Wind contributes to peak load (2013 fleet capacity value: 13.3%)
- "MISO does not currently anticipate significant operational management issues in the next several years."

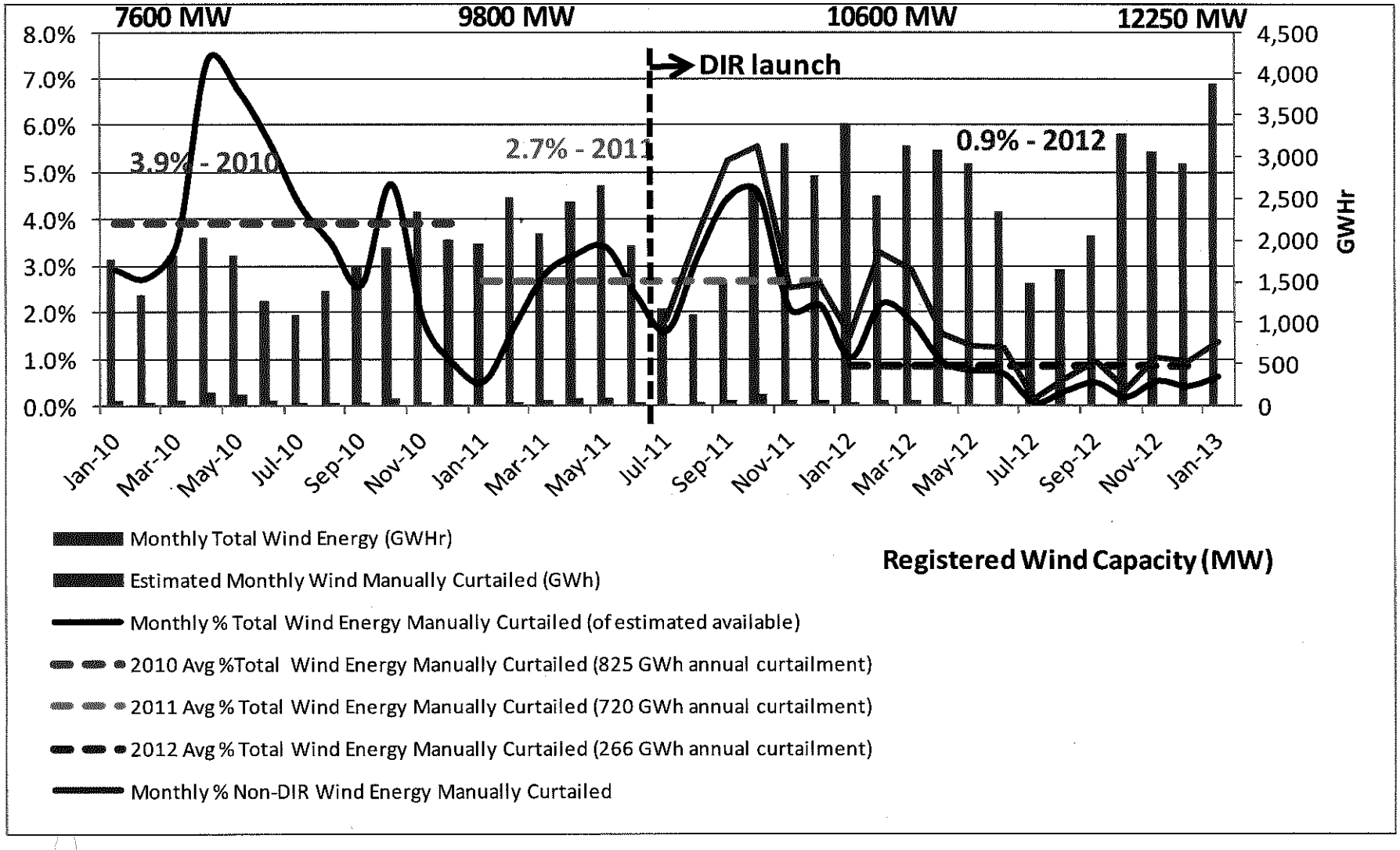
Sources: MISO Management Presentation to BOD (Markets Committee) 2/15/12; MISO 11/27/12; MISO BOD Markets Committee discussion 2/20/13

Wind Energy & DIR have Increased in MISO



Source: MISO, Informational Forum, 2/16/13

Drop in Manual Wind Curtailments - MISO



Sources: Midwest ISO, Feb 2013 RSC & monthly Informational Forum presentations

Conclusion

- MI can produce enough wind energy to exceed current RES
- MI could reach an RES of 30% using as little as 0.2% of potential wind energy forecasted for MISO and OH
- MI should evaluate *cost of wind energy from higher capacity areas + additional transmission* versus *cost of in-state wind energy*
- Variability does not mean Unreliable
- DIR and improvements in wind forecasting have increased the use and integration of wind energy – lowering cost of wholesale market energy and of wind energy

Thank you

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Talking Points for
Wind on the Wires Presentation at Michigan Energy Public Forum – Marquette
April 12, 2013

Readying Michigan
to Make Good Energy Decisions

Wind Energy Can Meet Michigan's Future Needs

SLIDES 1 & 2

Good afternoon Director Bakkal and Chrmn Quackenbush.

You have asked for facts related to affordability, reliability and the environment. Today I am going to talk about renewable energy and how utility scale wind can provide sufficient energy to meet a higher RES requirement, from either within Michigan or from outside Michigan, how wind energy is reliable and the steps MISO has taken to integrate the recent increase of wind energy into the transmission system with the result of lowering overall wholesale transmission costs, wind energy costs and improving system reliability.

SLIDE 3

The most recent value for Michigan's total retail sales available from the U.S. Energy Information Administration are from 2010. That information shows that Michigan consumers use approximately 103,649,219 MWhs in 2010. (U.S. E.I.A., state electricity profiles – Michigan).

The Wind Energy Resource Zone Board identified 4 potential wind energy zones. The Board estimated that those zones could produce between 9.9M MWhs and 17.7M MWhs of renewable energy. That is between 9.5% and 17% of Michigan's renewable energy standard. (*Final Report of the Michigan Wind Energy Resource Zone Board* at 5).

NREL has estimated the available windy land in Michigan could produce 169,221,000 MWhs per year. (NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011)). That is approximately 150% of the total electricity demand in Michigan in 2010.

SLIDE 4

The diagram on the left shows energy sources and energy sinks in the MISO footprint in the future. Michigan is blue, which means it is a sink, or needs electricity.

The diagram on the right depicts the high voltage transmission lines around Lake Michigan. Basically, Michigan is tied to MISO and PJM by 4 transmission lines – two 345 kV lines into Indiana and 2- 345 kV lines into Ohio. Relatively speaking, Michigan appears to be an island and should consider its power flows when thinking about future low cost energy.

SLIDE 5

While Michigan appears to have sufficient renewable resources to provide more than 10% of the electricity demand, neighboring states and MISO states have plenty of wind energy for Michigan to draw upon. If Michigan were to expand the geographic location of renewable energy sources that could be used to meet the RES, MI could easily use wind energy sources to provide 25-30% of its energy demand. Based on NRELs forecast of wind energy potential in MISO states, Michigan could obtain 15% of its electricity demand from 0.1% of the wind energy potential within MISO. (NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011)). Stated another way, 0.2% of the wind potential in MISO states and in Ohio would allow Michigan to attain a 30% RES. Through MISO, Michigan has access to higher capacity wind facilities that could offer wind energy at prices lower than what could be achieved within Michigan. This should be considered when weighing policy changes to the RES.

SLIDE 6

Many commenters have expressed concern that wind facilities have capacity factors lower than coal, natural gas and nuclear. The fact that wind energy is variable does not mean that it is unreliable. As we will discuss in the next few slides, MISO has seen a sharp increase in wind generation, has had little to no serious problems with integrating that generation, and does not foresee a problem integrating wind energy over the next few years. MISO has taken steps to improve the integration of wind into its system and MISO has reduced the curtailments of wind farms. The reduction in curtailments means wind facilities can operate for more hours and offer a lower price for its energy. The overall effect is lower prices for ratepayers.

SLIDE 7

The facts about wind generation and reliability are that the wind speed changes relatively slowly and is predictable. Methods used to predict wind speed are improving and industry experts expect the models to continue to improve as more data becomes available and programs become more sophisticated.

Wind speed changes more slowly than changes in electricity supply, demand or a plant outage.

Wind farms have numerous turbines, so you always have electricity being produced even if one turbine is not operating. That is not the case with a centralized generating plant like a coal, natural gas or nuclear plant.

Since the RES was approved in 2008, MISO has put a few measures in place to improve the integration of wind into the electricity grid. MISO requires wind facility operators to submit day-ahead forecasts. The forecasts become more accurate the closer in time they are to the actual time of generation.

MISO has implemented dispatchable intermittent resource provisions. This allows MISO to remotely curtail or start up a windfarm to alleviate transmission line congestion or optimize

usage of line capacity. Wind facilities put in service after April 1, 2005 and that do not have firm transmission service must switch to DIR.

SLIDE 8

Wind generation has increased ten-fold in five years in MISO

- **Installed wind capacity: 12,270 MW** (Registered March 2013; 9,544 MW registered as DIR in the March 2013 Commercial Model)
- Record wind peak: 10,012 MW (Set 11/23/12; ~25% of gen output at the time)
- **Wind generation: 6.4% of total MISO energy over the last 12 months** (Feb12-Jan13; % of MISO RT load)
- **Congestion is increasing**; MVP lines will help mitigate

MISO operations has gained significant experience successfully integrating wind

- Wind helps keep prices low for MISO customers and the end-user consumer
- Output variability is being mitigated by geographic diversity
- Wind forecasting has improved and is expected to continue improving
- Wind has had a small impact on regulation reserves
  Contingency reserves have never been deployed due to a drop in wind output
- Wind contributes to peak load (2013 fleet capacity value: 13.3%)
- "MISO does not currently anticipate significant operational management issues in the next several years."

SLIDE 9

This chart shows that the percentage of wind facilities on DIR has increased since June 2011, and is now 50-55% of total wind being produced in MISO.

This chart also shows that the total monthly wind energy being produced has increased to approximately 3,800,000 MWhs per month.

SLIDE 10

This chart shows that as the % of wind facilities using DIR has increased, the annual percentage of manual curtailments has dropped sharply year-over year from 2010 to 2012, and the percentage of total wind energy manually curtailed has also dropped dramatically.

The implementation of both the Day Ahead Forecasting and DIR has been viewed as a success by the wind community. MISO has pro-actively implemented market-based solutions to integrate increasing penetrations of wind. This has enabled wind to compete on a level playing field with other types of resources. This is in contrast to other regions of the country, e.g. Northwest, who have initiated integration charges for wind in lieu of developing market-based solutions or changing operational protocols to more cost-effectively integrate wind into the system. Additionally, uneconomic wind curtailment has basically disappeared since the implementation of DIR which has a positive impact on wind plant operations.

SLIDE 11 CONCLUSION:

Michigan can achieve a higher percentage of electricity from cost effective renewable energy, whether it maintains an in-state policy or allows electricity service providers to use renewable energy from resources interconnected to MISO.

When Michigan changes its RES, it should evaluate the cost effectiveness of wind energy from regions with higher wind energy capacity factors versus those from within Michigan.

Improvements in wind speed modeling and the use of Dispatchable Intermittent Resources have improved the use and integration of wind energy into MISO, which lowers the cost of wind energy and the overall cost of energy for ratepayers.

Thank you,

Sean R. Brady
Regional Policy Manager
Wind on the Wires
sbrady@windonthewires.org

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If you wish to speak today, please complete the following:

Name: Kerry Noble

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Phone: 906-249-3333

Email: Kerry@hesmgt.com

Topics you wish to address today:

a. ___ **Renewable Energy Portfolio Standards**

b. X **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): Energy Audits

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If you wish to speak today, please complete the following:

Name: Rick Wilson

Affiliation (if any): Heritage Sustainable Energy

Phone: 231-218-1725

Email: rick@rockmi.com

Topics you wish to address today:

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b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): _____

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Heritage
Sustainable Energy

April 12, 2013

Governors Energy Policy Forum
Marquette, MI

Good afternoon.

My name is Rick Wilson and I am the Vice President of Operations for Heritage Sustainable Energy.

Thanks to Gov. Snyder, Chairman Quakenbush and Director Bakkal for hosting these important community forums which are being held throughout our great state of Michigan.

Heritage is a Michigan-based and Michigan-financed wind energy developer, owner and operator. We currently own and operate two (2) wind farms in Michigan with a total installed capacity of 88 MWs. The 60 MW Stoney Corners Wind Farm consists of 29 wind turbines installed on the productive dairy lands of McBain, Michigan. The 28 MW Garden Wind Farm, is on the Garden Peninsula in Delta County, right here in the UP.

The founder of Heritage, Marty Lagina, was born and raised in Kingsford, and is a grad of Michigan Tech and the University of Michigan. He is proud to have brought a wind project and its multiple benefits here to the UP.

The clean, renewable electricity generated by these two projects, although technically consumed locally, is sold to Michigan utilities Consumers Energy, Detroit Edison and Traverse City Light and Power.

Heritage's business focus and intent is to make continued investment in Michigan where we have wind energy project development initiatives of over 500MWs continuing across the state from the UP to the Thumb.

The primary point I would like to make today is that PA 295 has been a truly successful legislative tool. It is resulting in multiple tangible benefits for landowners, communities, and the broad citizenry throughout the State of Michigan. PA 295 is working on all cylinders.

121 East Front Street, Suite 200, Traverse City, Michigan 49684
Telephone: 231-935-4500 Facsimile: 231-929-0242
www.heritagewindenergy.com

Over one thousand MWs of new electrical generation, located in Michigan, has been installed;

Reliable electrical generation, with FREE fuel, is located here, in Michigan;

Michigan students are training to become the technicians to design, manufacture, and operate new, high tech electrical generation;

Michigan citizens are building and operating wind farm facilities;

Entrepreneurs here in Michigan, are investing in businesses to design, engineer and manufacture towers, blades, hubs and multiple component parts for the most advanced wind turbines in the world, to be used in Michigan, and across the globe.

Michigan farmers are realizing new, consistently reliable revenues from their land through the utilization of the natural resource passing above, while minimizing any usage of their valuable farmland for continued crop production – This is the ultimate in Michigan farmland preservation.

The state, counties and local communities are realizing extraordinary sources of revenue from the personal property tax on investments of hundreds of millions of dollars in Michigan wind farms.

Michigan's air and Michigan's water is cleaner;

You recognize that I am emphasizing the focus on Michigan (*...and it would have helped even more if we would have won that basketball game the other night*).

But to build on one of the most successful advertising themes, PA295 is truly "Pure Michigan".

Thank you.

Sincerely,

Rick Wilson
Vice President
Heritage Sustainable Energy, LLC

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If you wish to speak today, please complete the following:

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Affiliation (if any): UP Power Co / WI Public Service Corp / Integrys Energy Group

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Email: dcforsberg@integrysgroup.com

Topics you wish to address today:

a. ✓ **Renewable Energy Portfolio Standards**

b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): _____

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If you wish to speak today, please complete the following:

Name: JEFFERY LOMAN

Affiliation (if any): KBIC MEMBER

Phone: 907 720-8680

Email: jeffery loman@mac.com

Topics you wish to address today:

a. X **Renewable Energy Portfolio Standards**

b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): Pollution From Biomass power – injury to treaty trust Resources

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If you wish to speak today, please complete the following:

Name: Jim Evans

Affiliation (if any): –

Phone: 231 871 0044

Email: _____

Topics you wish to address today:

a. ✓ **Renewable Energy Portfolio Standards**

b. ✓ **Energy Optimization / Efficiency Standards**

c. ✓ **Electric Choice**

d. ✓ **Other Additional Energy Topic**

(Please specify): _____

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If you wish to speak today, please complete the following:

Name: Summer Star

Affiliation (if any): Michigan Committee to Ban Fracking

Phone: (716) - 319 - 8813

Email: sstar@nmu.edu

Topics you wish to address today:

a. X **Renewable Energy Portfolio Standards**

b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

d. ___ **Other Additional Energy Topic**

(Please specify): Hydraulic Fracturing

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If you wish to speak today, please complete the following:

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b. ___ **Energy Optimization / Efficiency Standards**

c. ___ **Electric Choice**

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Steel Clad Aluminum Brake

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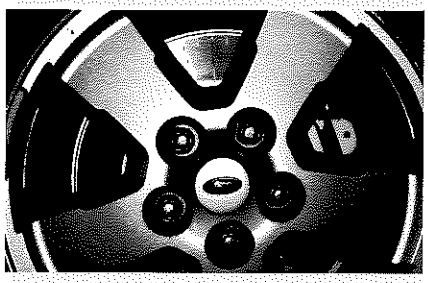
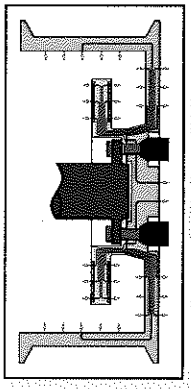
Advantages:

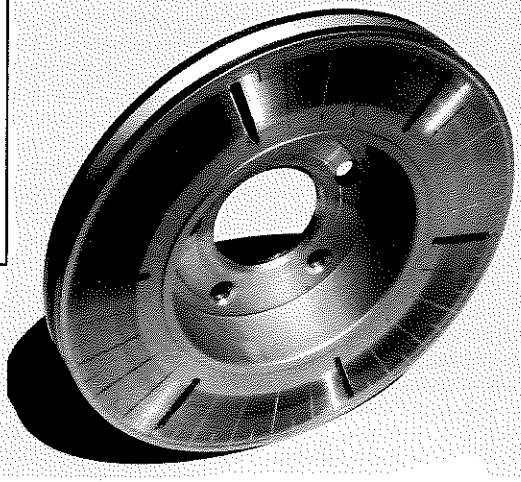
- 30% to 50% weight reduction
- Less brake pad drag
- Remarkable gas mileage increase up to 10%
- Faster heat dissipation and lower braking temperatures
- Greater corrosion resistance
- No heat dissipation degradation due to rusting
- Approximately 30% less wear on brake pads
- Lasts over 10 years or 100,000 miles
- Shorter stopping distance
- Faster car acceleration
- More precise steering due to un-sprung weight reduction



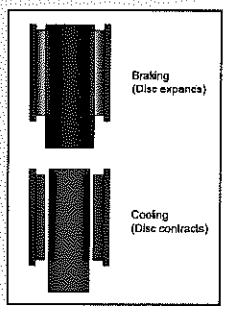


Incorporates a better steel with dozens of slots to increase the braking friction.

Uses connected aluminum rim as the brake heat sink and radiator to lower brake temperatures.



Utilizes greater thermal expansion coefficient of aluminum to create a "force free pad return" -reducing pad drag and increasing gas mileage.



The innovative SCA brake technology has a wide potential market to serve ordinary peoples for their vehicles with many benefits. Successful commercialization of this technology will significantly reduce oil consumption and greenhouse gas emissions and create tens of thousands manufacturing jobs for the United States. See reverse side for more information.

Currently Available Rotors for:

- Ford Escape
- Mercury Mariner
- Chevrolet Equinox
- Saturn VUE
- Toyota Camry
- Toyota Prius
- Toyota Corolla
- Toyota Sienna
- Toyota Solara
- Toyota Avalon
- Lexus ES300
- Honda Accord
- Honda Civic
- Honda CR-V
- Honda Element
- Dodge Caravan
- Chrysler Town & Country

More coming soon!

Check www.litebrake.com for update information

LiteBrake Tech, LLC

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Hancock, MI 49930
USA
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Dr. Scott Huang
Phone: 906-370-6530
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Steel Clad Aluminum Brake

Bring Benefits to Consumers, Reduce Oil Consumption, Improve Environment, and Create Manufacturing Jobs

There is a huge potential market for the SCA brake rotors. Passenger cars are usually installed with two front rotors and two rear drums for their brake systems. Nowadays four brake rotor systems become more and more popular because of their better braking performance. The current US auto sales is about 14M/yr. Assuming four rotors per car, the annual demand for the OEM brake rotors is 56M/yr. Brake rotors are consumable parts. The annual demand for the aftermarket replacement brake rotors is about at the same level, i.e., 56M/yr. Considering worldwide, the potential market is hug.

Due to the lighter rotating weight, less pad drag, and perhaps slight higher tire pressure increase during braking, the SCA rotor has shown remarkable gas mileage increase. Assuming 5% increase, 135M passenger cars on the road, and gasoline priced at $4 per gallon, the successful commercialization of this technology could save 3.87B gallons of gasoline, worth of $15.6B and reduce 35.1M tons of CO_2 emission annually in the US.

Aluminum based brake rotor is a priority research topic in the DOE 1999 Aluminum Industry Roadmap for the Auto Market. After 13 years, no satisfied technology has been developed except the SCA brake rotor technology. The government support in further R/D and commercialization is desired to greatly increase the chance of success and competiveness with the imported foreign low value cast iron rotors.

LiteBrake Tech, LLC

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USA
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Gas Mileage Tests*

Vehicle	Front Brakes	Test MPG	EPA MPG
1998 Ford Windstar FWD Van, 6 cyl, 3.8 L	Cast iron rotors	21.8	22
1998 Ford Windstar FWD Van, 6 cyl, 3.8 L	SCA rotors	24.1	
2008 Ford Escape 4WD, 6 cyl, 3.0 L	Cast iron rotors	21.0	22
2008 Ford Escape 4WD, 6 cyl, 3.0 L	SCA rotors	23.4	

* high way gas mileage, driven with full tanks of fuel to empty

LINK

FMVSS-135 Performance Criteria Comparison

Link Test # 055555 Customer # IMP # 5

Section	Test Load	FMVSS Required	Actual Test
Cold Effectiveness	GVWR	Stopping Distance less than 60m	Passed
High Speed Effectiveness	GVWR	Stopping Distance less than 110m	Passed
Engine Off	GVWR	Stopping Distance less than 60m	Passed
Cold Effectiveness	LLVW	Stopping Distance less than 60m	Passed
High Speed Effectiveness	LLVW	Stopping Distance less than 110m	Passed
Failed ABS	LLVW	Stopping Distance less than 70m	Passed
Hydraulic Circuit Failure	LLVW	Stopping Distance less than 95m	Passed
Hydraulic Circuit Failure	GVWR	Stopping Distance less than 95m	Passed
Failed ABS	GVWR	Stopping Distance less than 70m	Passed
Failed Booster	GVWR	Stopping Distance less than 95m	Passed
Hot Performance	GVWR	Stopping Distance less than 8m	Passed

SCA Rotor Consumer Cost Saving Estimate

Example #1, 2008 Ford Escape 4WD, 3.0 L, 6 cyl, Regular Gasoline		
Annual Fuel Cost with Cast Iron Rotors*	$2,950	$2,950
Gas Mileage Increase with SCA Rotors	5%	10%
Annual Fuel Cost Saving	$148	$295
Front Pad Replacement Cost (high end)**	$225	$225
Front Pad Replacement Cost (low end)**	$157	$157
Labor (high end)***	$107	$107
Labor (low end)***	$84	$84
Pads (high end)***	$111	$111
Pads (low end)***	$69	$69
Tax on Parts	6%	6%
Front Rotor Replacement Cost (high end)****	$495	$495
Front Rotor Replacement Cost (low end)****	$333	$333
Labor (high end)***	$127	$127
Labor (low end)***	$99	$99
Rotors + Pads (high end)***	$347	$347
Rotors + Pads (low end)***	$221	$221
Tax on Parts	6%	6%
Total Ten Year Cost Saving (high end)	$2,194	$3,669
Total Ten Year Cost Saving (low end)	$2,062	$3,440
Initial SCA Brake Installation Cost	$840	$840
Labor	$127	$127
Rotors	$598	$598
Pads	$75	$75
Tax on Parts	6%	6%
Net Ten Year Cost Saving (high end)	$1,354	$2,829
Net Ten Year Cost Saving (low end)	$1,221	$2,600

* based on the data for 2008 Ford Escape 4WD, 3.0 L, 6 cyl from http://www.fueleconomy.gov/
** assuming reduction of one time pad replacement in ten years due to the use of SCA rotors with 1/3 longer pad's life
*** based on the data for 2008 Ford Escape from http://repairpal.com/
**** assuming elimination of the rotor replacement need in ten years due to the use of SCA rotors with at least double life time

HYBRID ELECTRIC VEHICLE ENTERPRISE
TECHNICAL REPORT

SUMMER VUE ROTOR TESTING

DECEMBER 28, 2012

Written By:

James Parisot

~ ABSTRACT ~

The objective of the testing was to investigate claims of increased fuel economy due to changes in brake rotor material. The stock cast steel rotors were compared to an aluminum/steel composite rotor. The testing shows an average increased fuel economy of 5 mpge when using the aluminum/steel composite rotor.

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Vue Brake Rotor Testing

EXECUTIVE SUMMARY

The purpose of this project was to investigate reported fuel economy gains caused by using aluminum/steel composite brake rotors on a Saturn Vue. To investigate these claims, a 2009 Saturn Vue Hybrid fabricated by Michigan Tech's EcoCAR enterprise was repeatedly driven over a drive cycle in Houghton, MI. The Vue was instrumented to allow the recording of data which allowed fuel economy calculations. The results show an average 5 miles per gallon equivalent improvement when the aluminum/steel composite rotors were used.

INTRODUCTION

The main goal of this project was to investigate the reported fuel economy gains caused by using advanced steel/aluminum composite brake rotors. This was accomplished by utilizing an instrumented Saturn Vue Hybrid. The Vue was repeatedly driven over a chosen drive cycle. The instrumentation system output electric current draw from the battery, battery terminal voltage, vehicle speed, and the timestep. The first step of the calculations involved using equation 1 to find the power consumed by the vehicle.

$$Power = Voltage * Current \qquad 1$$

The EPA defines 1 gallon of gas as 33.7 kW-hr of electricity. The next step involved was to find the amount of kilowatt hours used at varying points in the drive cycle. To accomplish this, equation 2 was used.

$$kW - hr = Power(kW) * Timestep(hour) \qquad 2$$

The kW-hrs consumed was then converted into gallons of fuel consumed by utilizing equation 3 taken from the EPA's fuelecomony.gov (1).

$$Gallons = (kW - hr)/33.7 \qquad 3$$

Now that instantaneous fuel consumption is known, it can be converted into miles per gallon equivalent. To accomplish this, numerical integration was used. The velocity output was integrated to obtain the displacement of the vehicle. Using equation 4, instantaneous fuel economy (miles per gallon equivalent) was calculated.

$$mpge = \frac{displacement}{gallons} \qquad 4$$

The mpge was then averaged over the drive cycle. The test was completed four times for each set of brake rotors (four with the stock rotors and four with the aluminum/steel composite rotors).

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TECHNICAL APPROACH

The first step of the process for validating the brake rotor fuel economy improvements was developing a drive cycle for the vehicle. The drive cycle is shown in figure 1. The main goal of the route was to have a repeatable route that avoided as much traffic as possible. The chosen route mainly included country roads where other vehicles were hardly seen.

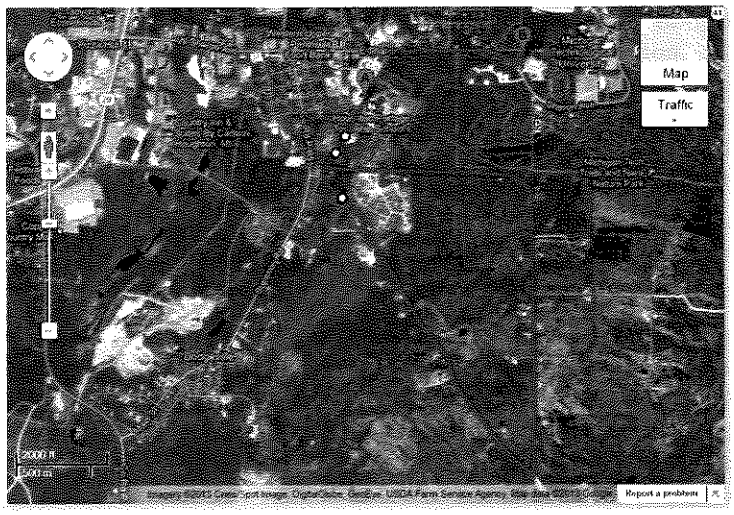

Figure 1Drive Cycle

Once the drive cycle was chosen, testing procedures were developed. The test procedures included: one driver that was consistent over all of the tests, windows open, air conditioning off, maintain as close to 25 mph as possible using a handheld gps unit for guidance. The vehicle began each test with a 95% state of charge. It then ran 2 circuits of the drive cycle. This was completed four times for each set of rotors.

ANALYSIS

Fuel economy was calculated by using data that was taken from sensors and recorded from the vehicles Mototron supervisory controlled by using a laptop. Battery current, voltage, and vehicle speed were recorded along with the timestep that they were recorded at. By following the equations derived in the introduction, an equivalent fuel economy was calculated. To validate the tests, velocity vs. displacement traces were constructed, as shown in figure 2. These traces are used to verify that the vehicle stayed reasonably consistent over the given drive cycles.

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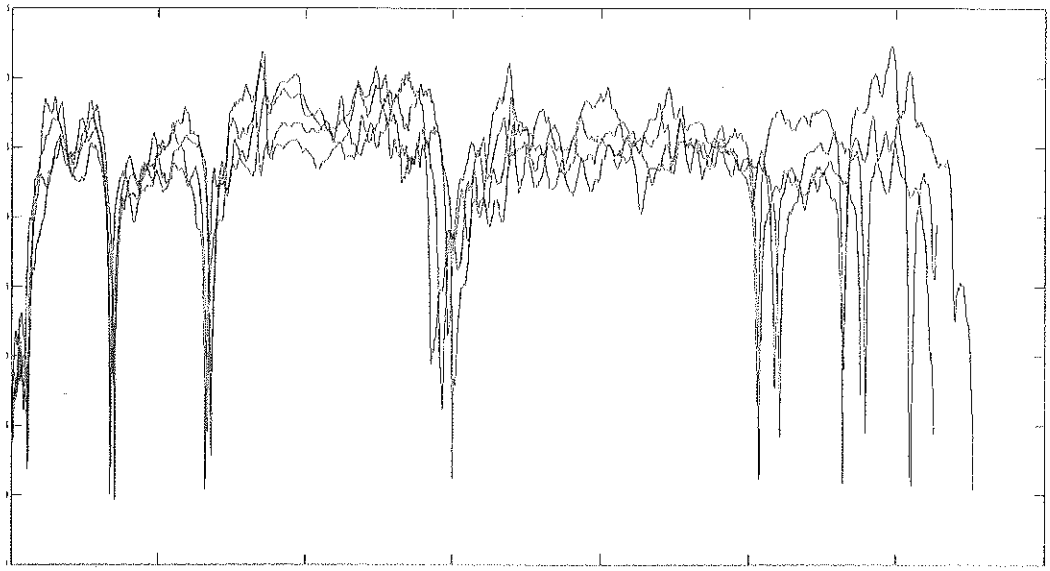

Figure 2 Velocity vs Displacement trace

RESULTS

Table 1 displays the results of the fuel economy testing. The composite rotor had a higher average and peak fuel economy when compared to the stock rotor.

MPGE OF ROTORS	STOCK ROTOR	COMPOSITE ROTOR
Run 1	104.2	112.8
Run 2	119.4	113.3
Run 3	108.0	110.5
Run 4	113.7	128.8
Average	111.3	116.4

Table 1: Fuel Economy Results

CONCLUSIONS

There were two main conclusions from the testing. The first conclusion was that the tests were run over a consistent drive cycle. Due to the accuracy of the equipment used, a 3 mph range for speed driven is acceptable. The gps unit reads to the nearest mph. It does not update instantaneously. Both of these are sources of error that account for the velocity fluctuations.

The second conclusion is that the brake rotors did improve the fuel economy. Both the average fuel economy and the peak fuel economy were higher for the composite rotors. These tests were run at low speeds. It is anticipated that the fuel economy increases would be greater at increased vehicle speeds.

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REFERENCES

1) US Department of Energy, Environmental Protection Agency, Fuel Economy.gov, Nissan Leaf Fuel Economy, http://www.fueleconomy.gov/feg/noframes/32154.shtml

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Steel Clad Aluminum Brake Technology

- Introduction
- Brake Thermal Design
- SCA Brake Theoretical Temperature Increase
- SCA Brake Heat Dissipation
- Brake Thermal Analysis
- Brake Temperature Tests
- Brake and Wheel Contact
- Pad Drag Reduction and Gas Mileage Increase
- Unsprung Weight
- Brake Dynamometer Tests
- Future Brake and Wheel Integrated Design
- Aluminum and Steel Bonding
- Aluminum and Steel Thermal Mismatch
- Rotor Wear Rate Reduction
- Pad Wear Rate Reduction
- Corrosion Prevention

Introduction

Our technology is an innovative automobile brake system which unites the steel clad aluminum (SCA) disc brake (brake rotor) and the connected aluminum alloy wheel as an integrated brake. The new brake exhibits many merits over the widely used cast iron disc brake.

Passenger cars are usually installed with two front disc brakes and two rear drum brakes. Nowadays, four disc brakes have become more and more popular because of their better braking performance. To execute braking, a pair of pads, one on either side of the disc brake, is pressed onto the surfaces of the brake, causing friction and slowing the car. One challenge in the design of disc brake is the need to absorb and dissipate the great amount of heat generated by brake friction.

Disc brakes are structured usually with ventilation channels for better heat dissipation. The braking heat is absorbed by the material mass between the two rubbing surfaces of each disc. The heat is dissipated, as the disc spins, through a) air convection on the two rubbing surfaces, b) air convection in ventilation passageways cast into the disc, and c) heat radiation of the two rubbing surfaces, if the surfaces become red hot. A high surface temperature reduces a brake pad's life and friction coefficient dramatically in regular brake systems, and is therefore highly undesirable.

Disc brakes demonstrate many advantages over drum brakes. However, their major disadvantage is the potential of incomplete brake pad disengagement (pad drag) after releasing the brake pedal, resulting in lower gas mileage.

The vented disc brakes are commonly made of cast iron and prone to rust. Over a period of two to five years, depending on working environment, vented disc brakes may develop severe rust inside the ventilation channels, blocking air flow and lowering the structure's integrity. Brake rusting is one of the major causes of brake repair.

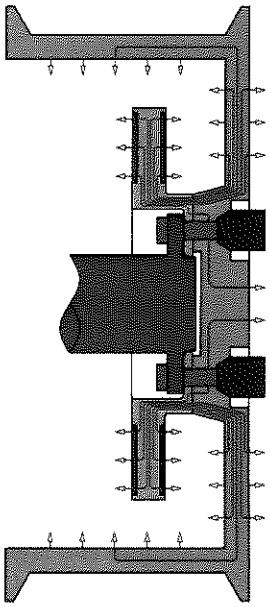

FIG 1. SCA integrated brake heat dissipation

The soaring gasoline price and predictions of future oil shortages have raised the demand for better fuel efficiency and reducing automobile weight. To further reduce weight, more iron and steel components, particularly rotating parts, need to be replaced with lighter materials. The brake systems currently in use are heavy. The disc brakes and drum brakes made of cast iron weigh 10 to 25 lbs each.

Aluminum is an excellent candidate material for the automotive disc brake application. In comparison with the cast iron disc brake, aluminum could reduce the brake weight by up to 50 percent. Aluminum also has great corrosion resistance, faster heat dissipation, equivalent strength, and higher ductility. The major technical barriers preventing the use of aluminum in brake systems include poor wear resistance and inability to withstand elevated surface temperatures generated during braking. To overcome both barriers requires enhancement of aluminum surface properties.

Dr. Scott (Xiaodi) Huang invented the SCA brake technology to solve the above problems. His research started at Michigan Technological University. This technology utilizes a new design concept in how to store and dissipate braking heat. The concept is based on the fact that most passenger cars are using aluminum wheels instead of steel wheels nowadays. The new concept is to utilize the aluminum wheel as a part of the brake system. The aluminum wheel functions as the major braking heat sink and radiator because it has a much larger volume and surface area over a disc brake (FIG 1). In addition, Aluminum also has a much higher thermal conductivity and a much higher heat capacity, which makes aluminum an ideal heat sink and radiator material. The greater heat capacity results in the capability of storing more heat with less temperature increase.

A typical brake design is to let the disc brake body store the maximum braking heat produced from one hard stop without its temperature increase exceed 230°C for ordinary passenger cars and dissipate the heat as quickly as possible to make it ready for the next braking. The SCA disc brake is a solid type in contrary to normal vented disc brakes. The reason for using a solid disc brake is that the solid disc brake has larger volume, therefore it can store more heat. In addition, the solid disc brake can conduct heat more easily to the connected aluminum wheel and is readily manufactured.

The SCA brake technology does not over emphasize disc brake weight reduction. Too much weight reduction reduces the capability of storing heat, resulting in higher brake working temperatures. Higher brake temperature decreases the friction coefficient between the disc and pads significantly. The lining

materials of brake pads are commonly bonded with an organic binder which limits the pad's maximum working temperature. Higher brake working temperatures increase pad wear considerably.

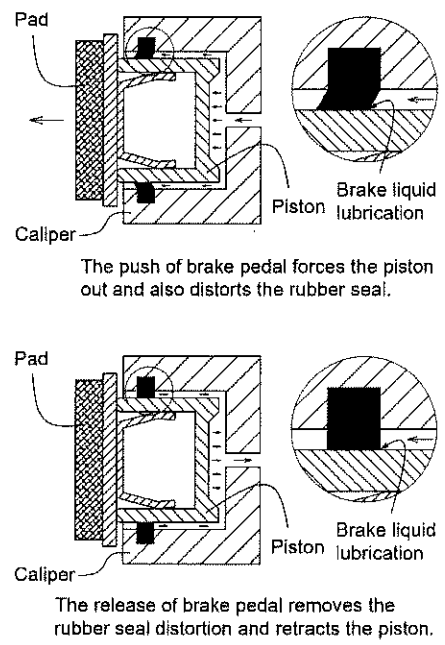

FIG 2. Current pad return mechanism (not very reliable)

Another key advantage of the SCA brake technology is the reduction of pad drag. When the brake pedal is released in the current disc brake systems, the inboard pad retracts about 0.006" by the distortion return of the caliper piston rubber seal as illustrated in FIG 2. Although the caliper can float toward the inboard or outboard, the outboard pad still maintains contact with the disc brake slightly in almost all cars causing pad drag. Typically, a brake pad induces approx 6.65-13.6 Nm torque of dragging. The pad drag could become more severe after the rubber seal loses its elasticity as the rubber degrades under repeated stress and high/low temperature cycles during its years of service. Further increased pad drag may be caused by the lateral runout (LRO) of traditional rotors if it exceeds the specifications. In comparison, the core of SCA disc brake is made of aluminum. Aluminum expands much more when subjected to heat due to its significantly higher thermal expansion coefficient. While the thermal expansion pushes the inboard and outboard pads wider apart the subsequent cooling contraction creates a clearance between the disc brake and the brake pads (both inboard and outboard) resulting in a "force free pad return" (FIG 3). This additional pad return causes no slower or softer brake response.

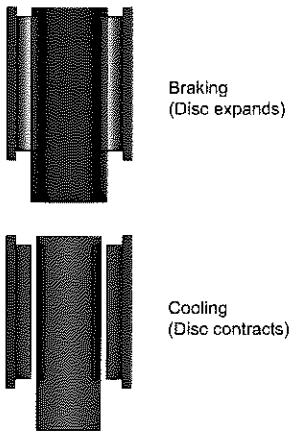

FIG3. SCA brake "force free pad return"

The steel clad on aluminum has several benefits. The disc brake can tolerate much higher surface temperatures. The steel cladding also functions as a thermal barrier in some degree to keep the aluminum underneath cooler. We have the freedom to select different steels for higher friction coefficient but still use the widely available pads for the cast iron disc brakes. For example, the average friction coefficients of cast iron and SCA disc brakes are 0.378 and 0.433 respectively measured by the dynamometer comparison tests. The technical challenge for the SCA disc brake is how to make a very robust steel and aluminum bond. The SCA brake technology is based on steel and aluminum mechanical interlocking and metallurgical bonding through a third metal. The SCA disc brake dynamometer failure mode tests showed that the pads were completely ruined but the SCA disc brake remained its integrity. Slots that assist in increasing the friction coefficient also relieves the thermal mismatch challenge between steel and aluminum.

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Numerous tests have been performed and passed, including the FMVSS-135 certification test and over 100,000 miles of road tests in the past ten years. Most of the road tests were performed on cars by mounting a SCA front disc brake on one side and a cast iron front disc brake on the other side. When a hard stop was executed the car tended to veer towards the side mounted with the SCA disc brake. The temperatures of the aluminum wheel connected with the SCA disc brake were always higher than the temperatures of the aluminum wheel connected with the cast iron disc brake. The higher wheel temperature may increase the tire pressure 1-3 psi temporally depending on braking conditions such as long downhill braking and repeated braking. The SCA disc brake shows the following merits in comparison with the cast iron disc brake,

- 30% to 50% weight reduction
- Less brake pad drag
- Considerably better gas mileage up to 10%
- Faster heat dissipation and lower braking temperatures
- Greater corrosion resistance
- No heat dissipation degradation due to rusting
- Approximately 30% less wear on brake pads
- Last over 10 years or 100,000 miles
- Shorter stop distance
- Faster car acceleration
- More precise steering due to un-sprung weight reduction

Brake Thermal Design

The general brake thermal design is to limit the theoretical temperature increase of brake after a hard braking below a certain level and derive the proper brake dimensions.

Equation (1) describes the theoretical temperature increase in °C, of a front disc brake.

$$T_{th} = \frac{(1-\emptyset)}{2}\left[\frac{W(V_1^2-V_2^2)}{2g\rho_r c_r v_r}\right] \qquad (1)$$

Where T_{th} = theoretical temperature increase, °C

$\emptyset$ = the percentage rear braking

W = vehicle weight, kg

V_1 = initial velocity, m/s

V_2 = final velocity, m/s

g = gravitational constant, 9.8 m/s^2

ρ_r = rotor body material density, kg/m^3

c_r = rotor body material specific heat capacity, J/kg °C

v_r = rotor body material volume, m^3

A typical thermal design goal is to limit the theoretical temperature increase to less than 230°C after a complete stop from 128 km/h at 0.7 g deceleration and GVW. The use of a brake body material with high specific heat and a solid disc brake help to meet this goal. Aluminum and its alloys are good candidate materials for this application.

SCA Brake Theoretical Temperature Increase

The SCA rotor is a solid steel clad aluminum disc with mounting hat. Its theoretical temperature increase equation is slightly different:

$$T_{th} = \frac{(1-\emptyset)}{2}\left[\frac{W(V_1^2-V_2^2)}{2g(\rho_r c_r v_r+\rho_c c_c v_c)}\right] \qquad (2)$$

Where T_{th} = theoretical temperature increase, °C

$\emptyset$ = the percentage rear braking

W = vehicle weight, kg

V_1 = initial velocity, m/s

V_2 = final velocity, m/s

g = gravitational constant, 9.8 m/s^2

ρ_r = rotor body material density, kg/m^3

c_r = rotor body material specific heat capacity, J/kg°C

v_r = rotor body material volume, m^3

ρ_c = clad material density, kg/m^3

c_c = clad material specific heat capacity, J/kg°C

v_c = clad material volume, m^3

With the same disc brake OD and thickness, a solid SCA rotor can store more heat than a vented cast iron rotor.

SCA Brake Heat Dissipation

An important aspect of disc brake design is how to dissipate braking heat as quickly as possible and make it ready for next braking. The calculation for heat dissipation for a traditional vented disc brake is based on the sum of convective cooling of rubbing surfaces, convective cooling of ventilation surfaces, and radiative cooling of rubbing surfaces. The SCA disc brake is a solid rotor and has the same convective cooling and radiative cooling of rubbing surfaces, but replaces the convective cooling of ventilation surfaces (Eq. 3) with conductive cooling to a connected aluminum wheel (Eq. 4).

$$q_{vent} = h_{vent} A_{vent} (T_r - T_\infty) \qquad (3)$$

Where q_{vent} = heat dissipation by air convection at ventilation surfaces, J/hr

h_{vent} = heat transfer coefficient of convection at ventilation surfaces, J/(hr m^2 °C)

A_{vent} = ventilation surface area, m^2

T_r = rotor body temperature, °C

T_∞ = ambient temperature, °C

$$q_{cond} = k_r A_{cross} (T_r - T_{wh-c}) / \left(H_{hat} + Th_{\frac{1}{2}d} + D_{d-h} \right) \qquad (4)$$

Where q_{cond} = heat dissipation by conduction to metal wheel, J/hr

k_r = rotor body thermal conductivity, J/(hr m °C)

A_{cross} = cross section area of rotor mounting hat side wall, m^2

T_r = rotor body temperature, °C

T_{wh-c} = wheel temperature at the contact surface with rotor, °C

H_{hat} = height of rotor mounting hat, m (reference letter A in FIG 4)

$Th_{\frac{1}{2}d}$ = half thickness of rotor disc, m

D_{d-h} = the distance between the disc middle circle and the mounting hat middle circle, m (reference letter B in FIG 4).

In the SCA disc brake design, q_{cond} is significant greater than q_{vent} of a corresponding cast iron disc brake, resulting in lower brake temperatures.

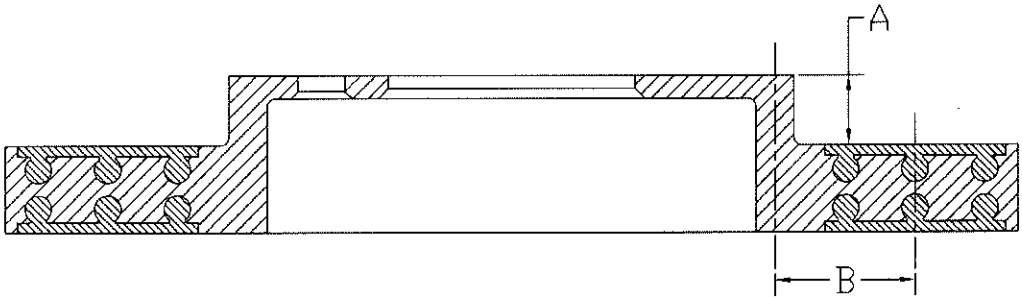

FIG 4. SCA rotor conductive heat transfer

Brake Thermal Analysis

Brake thermal analysis can be performed using the basic heat transfer equations, finite deference technique, and finite element method. FIG 5 compares the SCA rotor and the cast iron rotor with and without an aluminum wheel connected during repeated braking using the basic heat transfer equations. This analysis reveals that the connected aluminum wheel can lower the brake temperature several hundred degree down for the SCA rotor than the cast iron rotor.

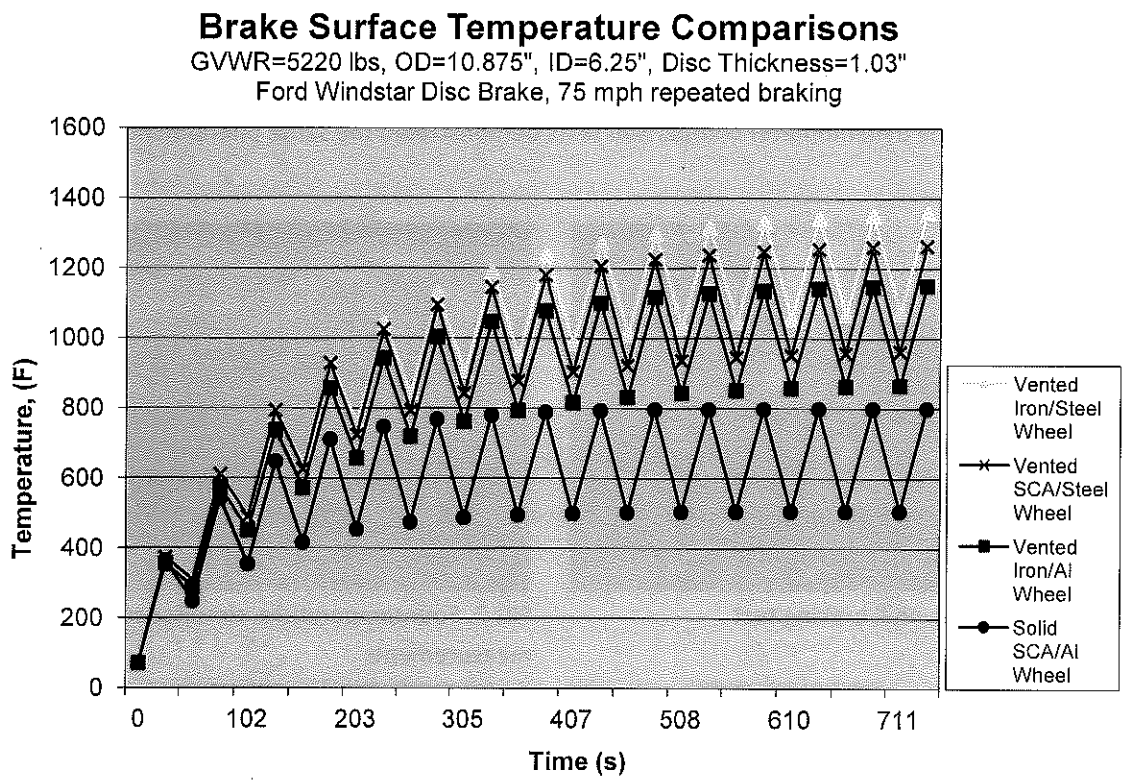

FIG 5. Thermal analyses of repeated braking

Brake Temperature Tests

A road test has been conducted on a 2008 Ford Windstar van mounted with a SCA rotor on the passenger side and a cast iron rotor on the driver side. The van was driven downhill with a series of hard braking to increase the brake temperatures (FIG. 6). The temperatures of the SCA rotor, the aluminum wheel against the SCA rotor, the cast iron rotor, and the aluminum wheel against the cast iron rotor were measured immediately (FIG. 7-9) at the end of downhill braking. FIG. 10 presents the downhill braking test result. The yellow curve is the temperature of the aluminum wheel against the cast iron rotor and the light blue curve is the temperature of the aluminum wheel against the SCA rotor. The purple curve is the SCA rotor rubbing surface temperature and the dark blue one is the cast iron rotor rubbing surface temperature. The road test results further verify that the SCA rotor temperature is much lower than that of cast iron rotor due to the heat transferred to the adjacent aluminum wheel more effectively. The dynamometer comparison tests demonstrated the same phenomenon.

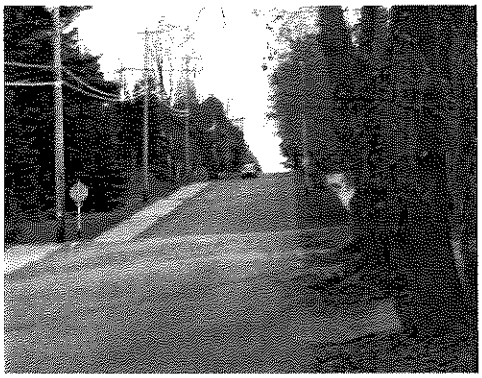

FIG 6. Downhill braking test

FIG 7. Four temperature simultaneous measurements

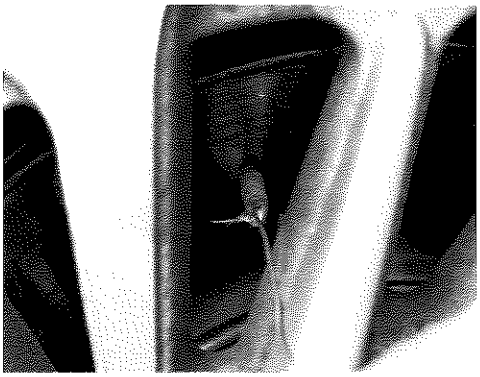

FIG 8. Rotor surface temperature measurement

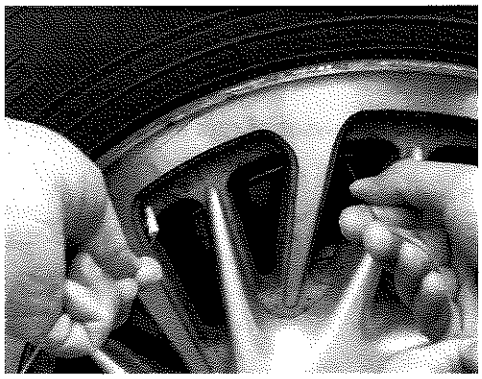

FIG 9. Aluminum wheel temperature measurement

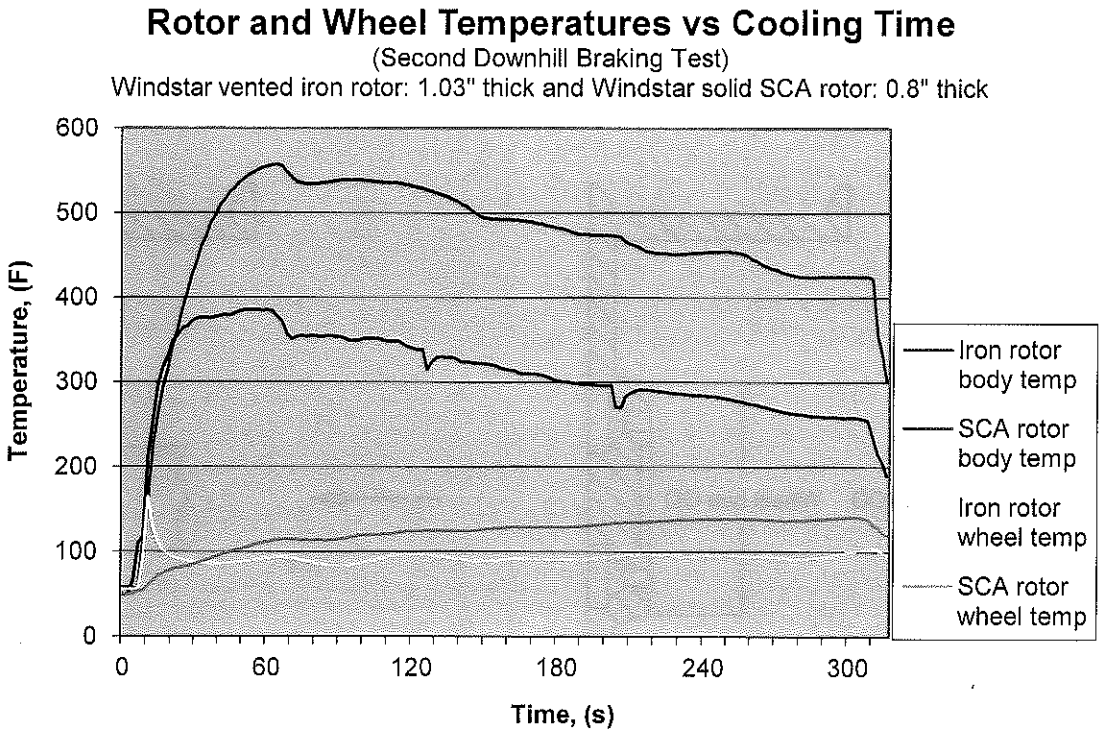

FIG 10. Vented cast iron brake and solid SCA brake surface temperature comparison

Brake and Wheel Contact

To make the SCA rotor and connected aluminum wheel as an effective integrated brake system, the SCA rotor hat and the aluminum wheel should have proper contact, which means sufficient contact area, larger rotor hat OD, larger aluminum wheel mounting hub OD, and clean contact surfaces (FIG 11).

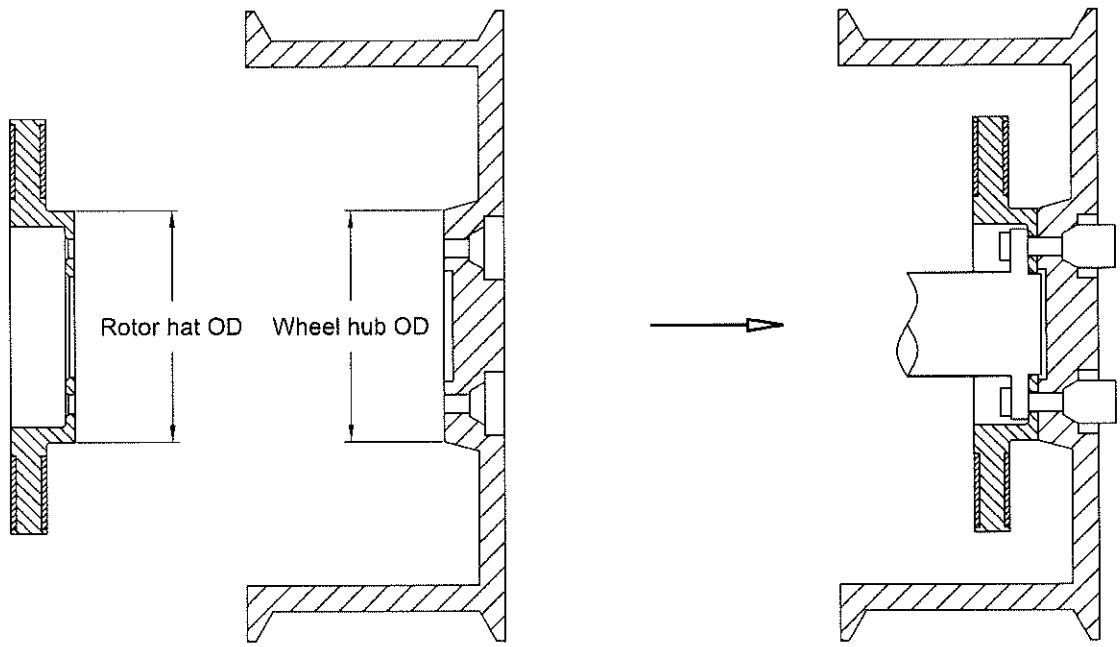

FIG 11. SCA rotor and aluminum wheel contact

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Pad Drag Reduction and Gas Mileage Increase

Referring to FIG 12, a brake assembly 8, includes a brake rotor 10, which includes mounting hat 12, mounted on a vehicle wheel 13.

A floating caliper 14, defines a hydraulic cylinder 16 into which a piston 18 is set. An inboard brake pad 20 is mounted on piston 18, such that when piston 18 is pushed outwardly from cylinder 16, inboard brake pad 20 contacts disc 11. This in turn causes caliper 14 to be pulled inwardly so that an outboard brake pad 22, held by caliper 14 contacts disc 11.

In currently available brake assemblies, when braking is no longer applied, the inboard brake pad 20 retracts slightly by the return of piston rubber seal deflection, but the outboard brake pad 22 does not necessarily retract adequately, and may continue to contact the rotor, causing a drag on movement and reducing fuel efficiency. In our technology, however, the core of rotor 10 is made of aluminum that has a high coefficient of thermal expansion and a high thermal conductivity, so that disc 11 expands during braking. Heat is then quickly conducted away by hat 12 into wheel 13, so that disc 11 shrinks when braking is no longer applied. As a result, outboard brake pad 22 is not positioned as far inward as it would be if not for the disc 11 expansion, and when disc 11 contracts, it withdraws from contact of outboard brake pad 22, thereby avoiding the problems caused by this contact. The other alternative in addressing the problem of the outboard pad 22 not retracting sufficiently after braking would be to enlarge the spread of the caliper 14, thereby spreading the pads 20 and 22 apart. This, however, worsens the brake pedal response, forcing the driver to press the brake pedal down farther before braking begins.

Two cars used for the long term road tests of the SCA rotors performed with significantly more driving miles for a full tank of as shown in Table 1. We believe that both lighter weight and pad drag reduction contribute to the gas mileage increase, but the latter cause is more significant.

Table 1. Gas Mileage Tests*

Vehicle	Front Brakes	Rear Brakes	Test MPG	EPA MPG
1998 Ford Windstar FWD Van, 6 cyl, 3.8 L	2 cast iron rotors	2 cast iron drums	21.8	22
1998 Ford Windstar FWD Van, 6 cyl, 3.8 L	2 SCA rotors	2 cast iron drums	24.1	
2008 Ford Escape 4WD, 6 cyl, 3.0 L	2 cast iron rotors	2 cast iron drums	21.0[1]	22
2008 Ford Escape 4WD, 6 cyl, 3.0 L	2 SCA rotors	2 cast iron drums	23.4[2]	
2008 Ford Escape 4WD, 6 cyl, 3.0 L	2 SCA rotors	2 cast iron drums	22.9[3]	
2008 Ford Escape 4WD, 6 cyl, 3.0 L	2 SCA rotors	2 cast iron drums	25.13[4]	

* highway gas mileage, traveled from full tanks of fuel to empty

[1]: 1 driver and 1 passenger, [2]: 1 driver and 2 passenger, [3]: 1 driver and 3 passengers, and [4]: 1 driver only

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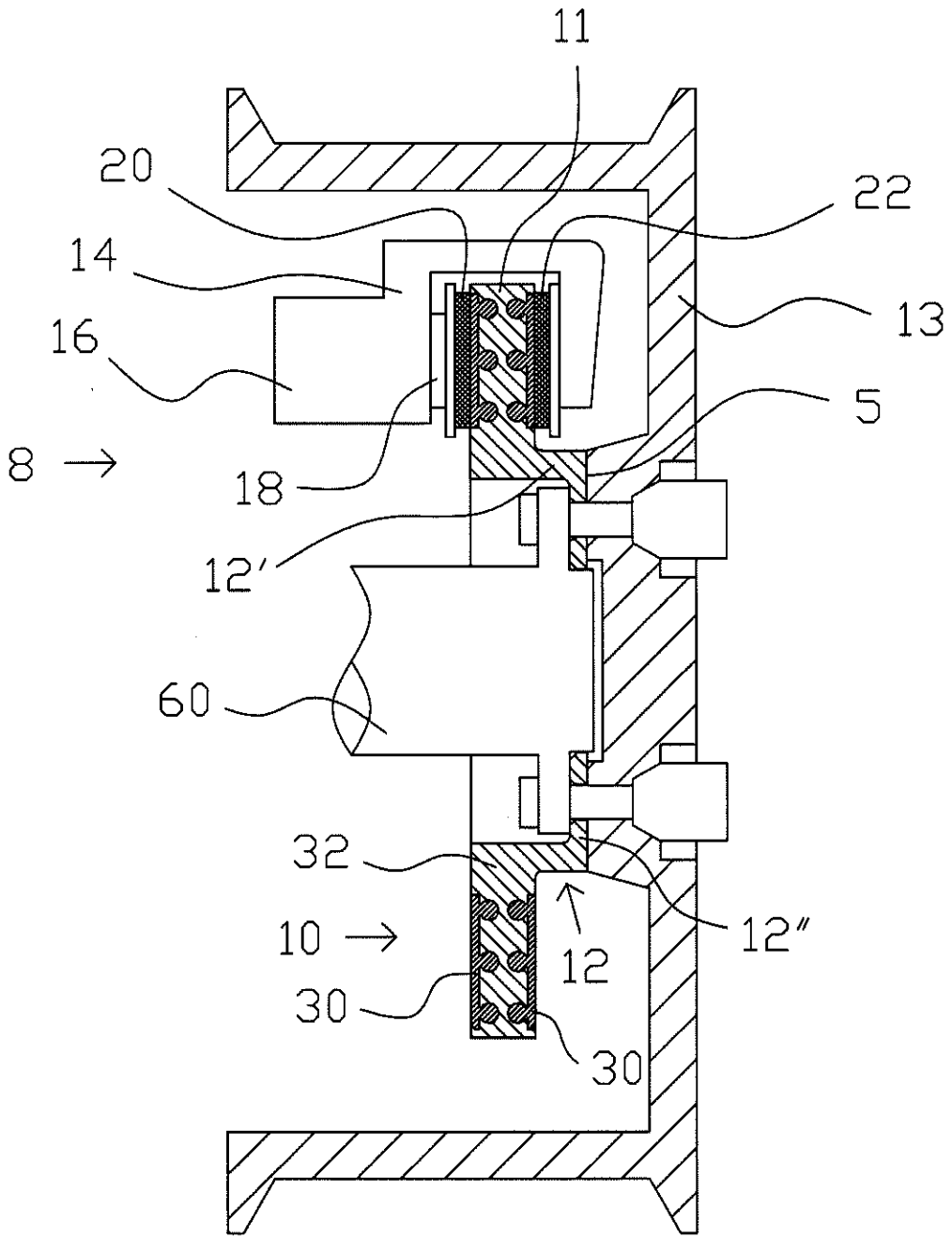

FIG 12. SCA brake system

Unsprung Weight

Unsprung weight is the mass of suspensions, wheels, brakes, and other components without the support of the suspensions. Unsprung weight reduction is desired not only due to the total vehicle weight reduction but also due to the improvement of tire road grip for better steering control (FIG 13) and reduction of road noise. The weight reduction by the SCA rotors is fairly significant to the total unsprung weight.

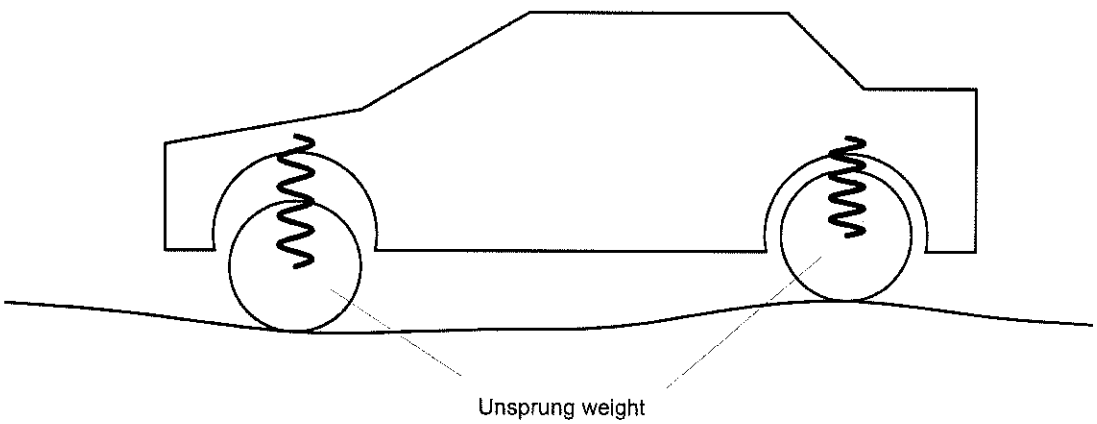

FIG 13. Lighter unsprung weight improves tire road grip and reduces road noise due to quicker response of wheels to bumpy roads

Brake Dynamometer Tests

Brake dynamometer tests simulate the braking conditions experienced on vehicles. SCA rotors have been subjected to a series of dyno tests to evaluate their braking performances, temperature responses, friction coefficients, rotor wears, pad wears, and so on. The obtained data were compared with those of the equivalent cast iron rotor tested under identical dyno conditions. The results verified the effectiveness of the new brake system of a SCA rotor connected with an aluminum wheel on greatly lowering rotor working temperatures as shown in Table 2.

The dyno tests confirm a readily achievable higher friction coefficient of SCA rotor over cast iron rotor as shown in Table 3.

The SCA rotor has passed the FMVSS-135 certification test (Table 4). The failure mode tests indicate that the pads will ruin completely first while the SCA rotor will remain its integrity.

Table 2. Brake and pad temperature comparisons with/without aluminum wheel mounted

Link Test #	Rotor Type	Mounted with Aluminum Wheel	Act. Inertia $Kg{\cdot}m^2$	Outer Pad Final °F	Rotor Final °F	Rotor-Pad Final Temp Difference °F
02A210	Cast Iron	No	37.23	528	819	**+291**
04A193	SCA	No	37.62	600	825	**+225**
066665	SCA	Yes	125.4	992*	690**	-302

Note: All temperatures are the 15th (last) stop measurements during the fade tests.
* higher pad temperature than that of 02A210 and 04A193 pads due to 066665 rotor subjected to 3.3 times higher inertia (vehicle weight)
** much lower temperature than that of 02A210 and 04A193 rotors although 066665 rotor was subjected to 3.3 times higher inertia (vehicle weight)

Table 3. Friction Coefficient Comparison*

Rubbing Surface	Average Friction Coefficient	Increase
Cast iron rotor	0.378	0
SCA rotor with type #2 steel cladding	0.433	14.5%

* Dyno test results with identical pads

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LINK

FMVSS-135 Performance Criteria Comparison

Link Test # 066665 **Customer # IMP # 5**

Section	*Test Load*	*FMVSS Required*	*Actual Test*
Cold Effectiveness	GVWR	Stopping Distance less than 63m	Passed
High Speed Effectiveness	GVWR	Stopping Distance less than 118m	Passed
Engine Off	GVWR	Stopping Distance less than 63m	Passed
Cold Effectiveness	LLVW	Stopping Distance less than 63m	Passed
High Speed Effectiveness	LLVW	Stopping Distance less than 118m	Passed
Failed ABS	LLVW	Stopping Distance less than 76m	Passed
Hydraulic Circuit Failure	LLVW	Stopping Distance less than 151m	Passed
Hydraulic Circuit Failure	GVWR	Stopping Distance less than 151m	Passed
Failed ABS	GVWR	Stopping Distance less than 76m	Passed
Failed Booster	GVWR	Stopping Distance less than 151m	Passed
Hot Performance	GVWR	Stopping Distance less than 67m	Passed

Table 4. Pass of FMVSS-135 certification test

Future Brake and Wheel Integrated Design

The current SCA rotor design is limited to simulate the existing cast iron rotor dimensions and the small aluminum wheel contact surface areas, not optimized for the best brake thermal performance. FIG 14-17 present the current aluminum wheel and rotor contact styles. Style A is preferred. Styles B and C are acceptable. Style D should be avoided. The most import aspect is to increase the contact surface OD and match it with the mounting hat OD of SCA rotor. If the SCA rotor is used, the aluminum wheel contact surface won't be contaminated by the rusted cast iron rotor. If allowable for the new integrated brake design, the SCA rotor performance will be further enhanced considerably.

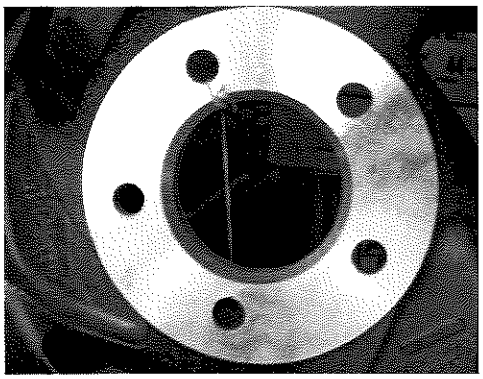

FIG 14. Style A contact

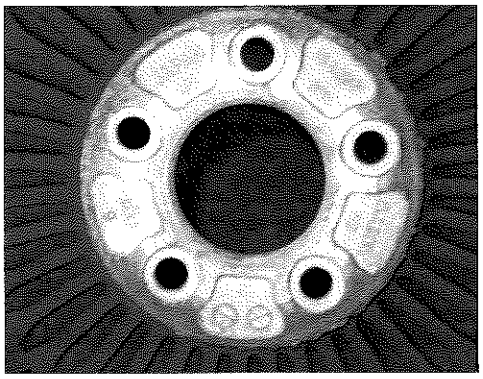

FIG 15. Style B contact

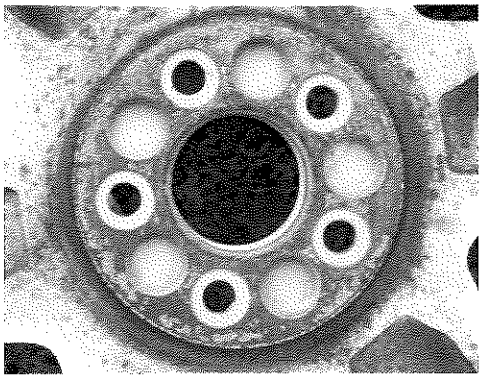

FIG 16. Style C contact

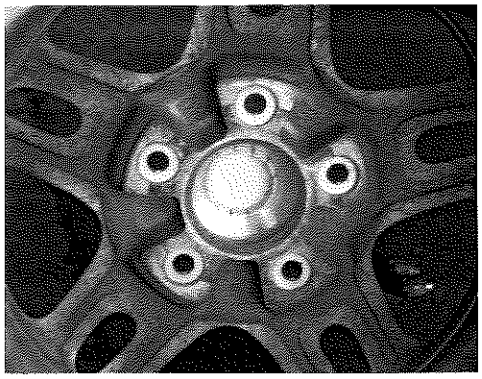

FIG 17. Style D contact

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Aluminum and Steel Bonding

It is a common knowledge that an aluminum based material cannot be surface-hardened, unlike steel material, by carbonizing or nitriding, due to the nature of aluminum. Aluminum to steel metallurgical bonding is also very difficult because of the always-existing oxide film on aluminum surfaces. To solve the problems, our steel and aluminum cladding technique is primarily based on mechanical interlocking assisted with a reaction metallurgical bonding to ensure absolute reliability for such safety sensitive application. The advantages of this technology include 1) simplicity; 2) low cost; 3) suitability for high-volume production; 4) good thermal barrier of steel layer to prevent over temperature of aluminum underneath; 5) great flexibility in selection of different grade and thickness of steels; 6) better wear resistance than cast iron; and 7) excellent bonding reliability.

Aluminum and Steel Thermal Mismatch

A challenge to the steel clad aluminum technology is how to deal with the thermal mismatch of steel and aluminum when subjected to braking heat. The SCA rotors are designed to make the steel claddings have many thin slots in a certain pattern (FIG 18). The steel claddings have the freedom to float when subjected to braking. In addition, the slots assist to further increase the friction coefficient.

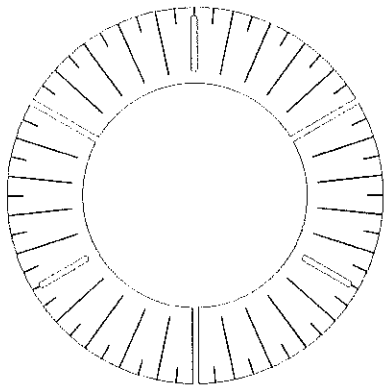

FIG 18. SCA rotor friction surface style

Rotor Wear Rate Reduction and Expected Service Life

The SCA rotor has demonstrated significant wear rate reduction without compromise of friction coefficient in dynamometer tests and a long term road test as presented in Tables 5 and 6. It is not difficult to understand the reason. FIG 19 is a typical microstructure of cast iron material. It consists of flake graphite and iron (i.e. very low carbon steel) matrix. The graphite has very low mechanical strength, therefore, the cast iron can be viewed as a low carbon steel with lot of flake porosity. If solid without porosity, the low carbon steel should have better wear resistance than the "porous low carbon steel". If a steel with carbon content similar to that of a cast iron matrix is selected, the steel could present similar friction coefficient as the cast iron matrix. The entrapped graphite is a kind of solid lubricant. Therefore, it lowers the friction coefficient of cast iron matrix. In other words, the selected steel shows both higher wear resistance and higher friction coefficient.

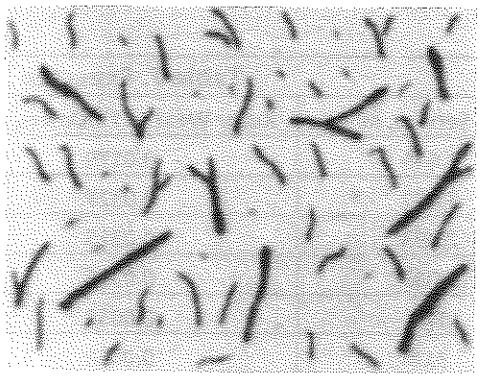

FIG 19. Typical cast iron microstructure, consisting of flake graphite and iron (i.e. low carbon steel) matrix

Over ten years, many SCA rotors have been installed on two cars and tested on city and highway roads. Table 7 presents the wear data of several tested rotors. The SCA rotors allow 2mm wear in their thickness by the design. The linear estimations of rotor wears for a 100,000 miles service are much less than 2 mm. We can expect the service life of the SCA rotors well over 100,000 miles on average.

Table 5. Disc Brake Wear Comparison*

Disc Brake Type	Weight Lost after Dyno Brake Test	Wear Reduction
Cast iron rotor	6.8 g	0
SCA rotor with type #1 steel cladding	3.9 g	42.6%
SCA rotor with type #2 steel cladding	5.0 g	26.5%

* Brake dynamometer test results of Dodge Neon cast iron rotor and Dodge Neon SCA rotor

Table 6. Rotor Wear Comparison*

Rotor Type	Original Thickness	Final Thickness	Wear	Wear Reduction
Cast iron	1.030"	1.014"	0.016"	0
SCA	1.014"	1.003"	0.011"	31.3%

* After driving 42,800 miles

Table 7. Expected Service Life Based on Rotor Wear*		
Rotor Service, miles	Rotor Wear in Thickness, mm	Linear Estimation of Wear after 100,000 Miles in Service, mm
2,615	0.0179	0.685
3,477	0.0327	0.94
2,493	0.0315	1.263
5,033	0.0336	0.667
170	0.0032	1.868
314	0.0038	1.213
2,304	0.0311	1.349

* The SCA rotors allow 2mm wear in thickness.

Pad Wear Rate Reduction

The pads against a SCA rotor have demonstrated great wear rate reduction in comparison with the pads against a cast iron rotor on a vehicle road test. A set of new pads (premium, purchased from Auto Value, Part #: PMP MKD601S), a new front SCA rotor (on the driver side) and a new front cast iron rotor (on the passenger side) were mounted onto a 2008 Ford Windstar van in February of 2004. After 42,800 miles of driving or in September of 2007, the pads were replaced and examined. Table 8 presents the pad's wear information. FIG. 20 is a closer look of the wears of the pad against the SCA rotor and the pad against the cast iron rotor. The pad against the cast iron rotor is almost completely worn-out but the pad against the SCA rotor has approximately 1/3 wearing material remained. The pad wear reduction is consistent with the lower working temperatures of the SCA rotor.

Table 8. Pad Wear Comparison*

Pads	Original Thickness**	Final Average Thickness	Wear	Wear Reduction
Outboard against cast iron rotor	0.416"	0.09"	0.326"	0
Inboard against cast iron rotor	0.416"	0.05"	0.366"	0
Outboard against SCA rotor	0.416"	0.17"	0.246"	24.5%
Inboard against SCA rotor	0.416"	0.18"	0.236"	35.5%

* After driving 42,800 miles; ** excluding 0.252" thick steel backing plate.

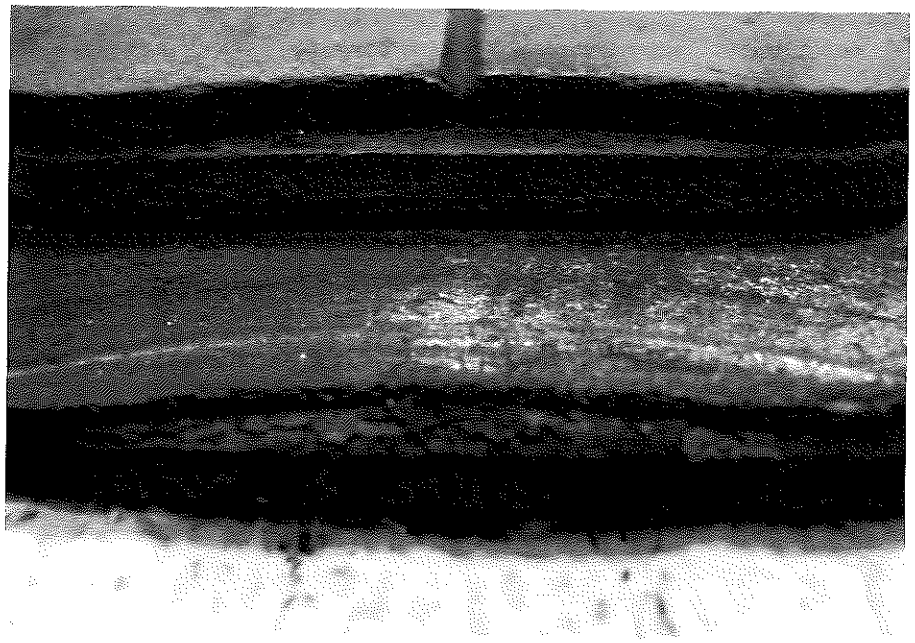

FIG 20. **Wear comparison:** the top pad was against the SCA rotor and the bottom pad was against the cast iron rotor on different sides of a 1998 Ford Windstar van.

Corrosion Prevention

Both brand new cast iron rotor and SCA rotor were mounted on different sides of a 1998 Ford Windstar van for a long term local and highway road test. The test lasted for 42,800 miles and four years including three winters in Houghton, Michigan, a place famous for heavy snowfall from 81 to 356 inches annually where lots of salt is used to melt snow and ice on the roads. Driving during winters is a good corrosion resistance test. FIG. 21 shows the appearance of the cast iron rotor and FIG. 22 shows the appearance of the SCA rotor after the four year test. The cast iron rotor rusted badly. The rust blocks the vents of the rotor, which is detrimental to heat dissipation. The SCA rotor shows some salt corrosion over its body, which does not affect its performance. A high temperature paint is now coated on all SCA rotors as a standard procedure over their non-friction but exposed surfaces to prevent the salt corrosion (FIG. 23). The paint won't affect the heat dissipation of SCA rotors otherwise to cast iron rotors since the SCA rotors do not rely on those surfaces for cooling.

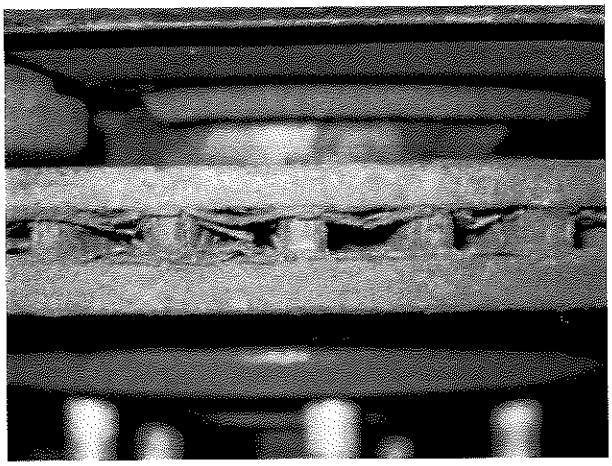

FIG 21. Cast iron rotor after four years in service

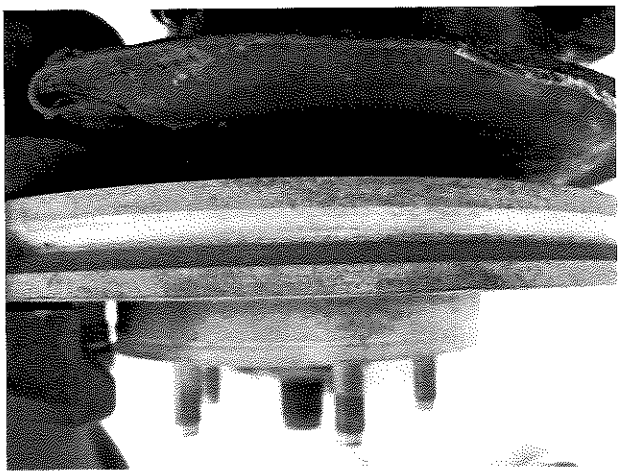

FIG 22. SCA rotor after four years in service

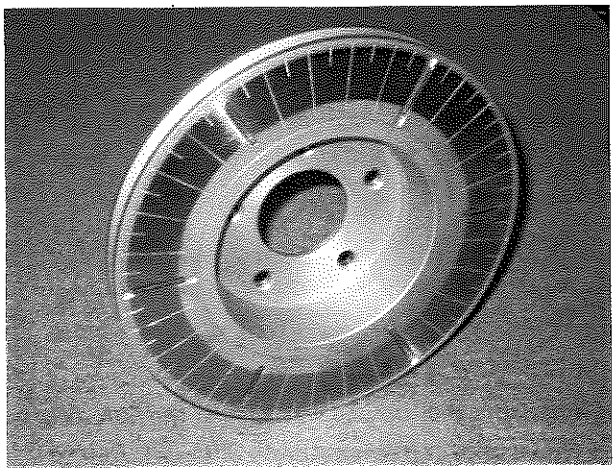

FIG 23. Newer version of SCA rotor with high temperature paint on non-friction and exposed surfaces

Property of LiteBrake Tech, LLC

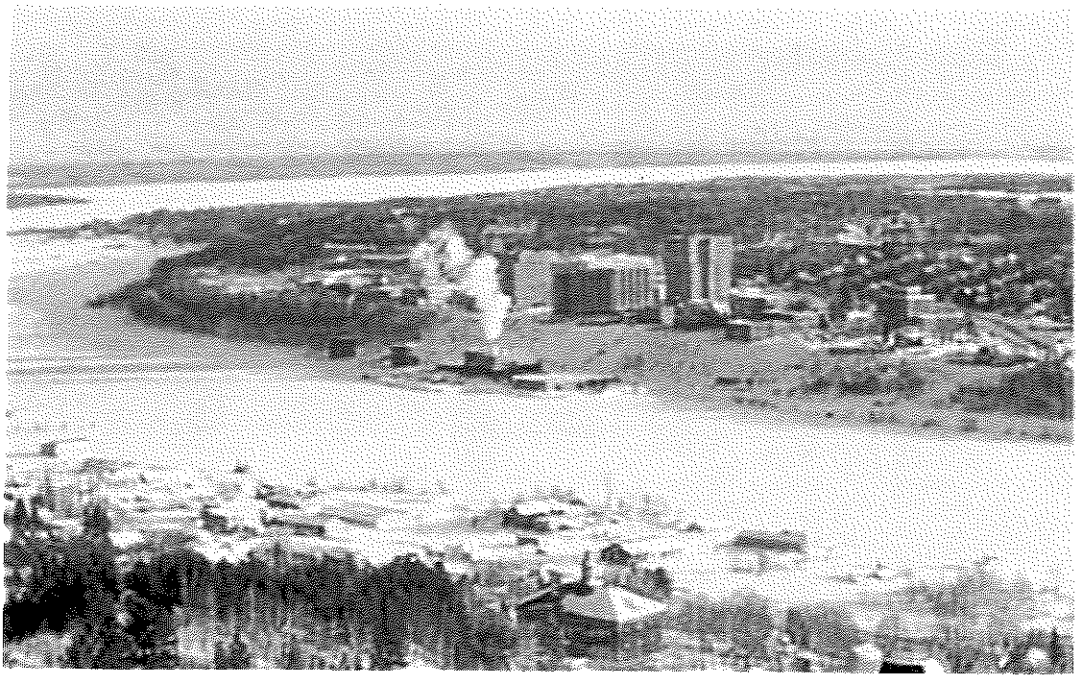

FIG 24. A winter view of Houghton and Hancock, Michigan

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Impacts of Fossil Fuel Power Generation in Michigan

Michael Murray, Ph.D., National Wildlife Federation
Aug. 28, 2012

All energy sources have some environmental impact, which can potentially include mining/extracting the raw fuels, producing/installing the generating equipment, operating and maintaining the generating system, disposing of waste, and decommissioning. Michigan residents are currently assessing the impact of substantial increases in wind turbines on wildlife. This fact sheet provides needed context: an overview of wildlife impacts in Michigan and the region from fossil fuel energy sources.

As of 2010, primary net electric power generation in Michigan amounted to 111,551,371 megawatt-hours (MWh), with a breakdown of:

- 58.8 % coal
- 11.0 % natural gas
- 26.6 % nuclear
- 1.1 % hydropower
- 0.3 % wind power
- 2.2 % other renewable fuels (wood, wood waste, municipal solid waste, biogenic/landfill gas)[1]

With approximately 360,000 MWh of wind generation in 2010, Michigan ranked seventh among the eight Great Lakes states, ahead of only Ohio in both wind energy generation and percentage of total power generation from wind.[2]

This fact sheet briefly reviews impacts of nonrenewable power sources on fish and wildlife, with a focus on fossil fuel generation and impacts from several key pollutants (in particular mercury and greenhouse gases).

Mercury: Emissions, Deposition, and Fish Tissue Response

The heavy metal mercury has long been of concern due to its toxicity to humans and wildlife. Mercury levels have increased in the industrial era (including in the Great Lakes region) due to human activities, including burning of fossil fuels (in particular coal), and

[1] U.S. Energy Information Administration (EIA), State Electricity Profile 2010, available from http://www.eia.gov/electricity/state/michigan/pdf/michigan.pdf; EIA, State Renewable Electricity Profiles 2010 (Michigan), available from http://www.eia.gov/renewable/state/michigan/.
[2] U.S. EIA, State Electricity Profiles 2010, *Op. Cit.*

mining and use of mercury in products. Mercury remains a concern in Michigan, including with respect to ongoing emissions and the importance of coal-fired power plants.

- Based on an analysis of 1999 emissions data, of the 4,573 lbs. of mercury released in Michigan, nearly 57 percent was released from coal-fired power plants.[3]
- The most recent EPA data indicates a slight decrease in mercury emissions in the state both for coal-fired power plants and overall (down to 4,286 lbs.), but these plants were still responsible for 53 percent of the state's emissions in 2008.[4]

Much of the mercury released from coal-fired power plants and other similar sources deposits locally or regionally, and some trends have been observed over the past 1-2 decades.

- An earlier study considering U.S. and Canadian sources showed that nearly 50% of the mercury depositing on Lake Michigan came from sources within approximately 60 miles of the lake. Those authors noted that "[o]verall, coal combustion in the United States was found to be the most significant source category contributing mercury through atmospheric deposition to the Great Lakes."[5]
- More recent modeling of mercury deposition in the Great Lakes continued to emphasize the importance of local and regional sources. For example, over 43% of mercury deposition to Lake Huron was attributable to sources within 250 miles of the lake. In addition, the Monroe (coal-fired) power plant was the single largest contributor of mercury deposition among all facilities modeled.[6] (Note that although some mercury emissions from coal-fired power plants in Michigan drift out of the state and have impacts elsewhere, Michigan is also impacted by out-of-state mercury emissions, including from coal-fired power plants in neighboring states, indicating the importance of fuel mix choices/policies in neighboring states as well.)
- Some trends in atmospheric mercury deposition have been measured over the past decade, through the Mercury Deposition Network. Although measured mercury concentrations decreased slightly from 2002 – 2008 at several Michigan sites, mercury deposition did not changes significantly. In addition, average mercury

---

[3] Michigan Mercury Electric Utility Workgroup, Michigan's Mercury Electric Utility Workgroup final report on mercury emissions from coal-fired power plants, June 20, 2005.

[4] U.S. EPA, 2008 National Emissions Inventory, available from http://www.epa.gov/ttn/chief/net/2008inventory.html.

[5] Cohen, M.; Artz, R.; Draxler, R.; Miller, P.; Poissant, L.; Niemi, D.; Ratte, D.; Deslauriers, M.; Duval, R.; Laurin, R.; Slotnick, J.; Nettesheim, T., and Mcdonald, J. (2004). Modeling the atmospheric transport and deposition of mercury to the Great Lakes. *Environmental Research* **95**(3):247-265.

[6] Cohen, M.D., Artz, R.S., and Draxler, R.R., 2007. Report to Congress: Mercury Contamination in the Great Lakes. National Oceanic and Atmospheric Administration, Air Resources Laboratory, April 17, 2007.

concentrations for the period in west central Michigan were among the highest in the Great Lakes region.[7]

- Research has indicated the direct link between atmospheric mercury deposition and fish mercury. For example, through modeling in Florida (with the Everglades Mercury Cycling Model), it was determined that there would be a nearly 1:1 correspondence between changes in atmospheric mercury deposition and mercury levels in fish. Furthermore, the majority of reductions in fish tissue mercury levels would be seen in about 10 years following major controls on air sources, though reductions to lower, stable concentrations would take up to 30 years or longer[8].

Mercury: Human Health, Fish, and Wildlife Concerns

Mercury has long been of human health concern, with more recent research increasingly identifying its potential to cause neurodevelopmental and other effects (in particular to fetuses and in young children) at relatively low exposure levels. In addition, research has shown the potential for mercury to counteract the cardiovascular benefits of fish consumption in adults.[9]

For over 40 years, the state of Michigan has warned fish consumers to restrict consumption of certain species in certain locations due to elevated mercury levels, and the state has had a statewide advisory covering all inland lakes for nearly two decades. The current statewide advisory (covering all inland lakes, reservoirs, and impoundments not otherwise listed) includes recommendations that women under 45 and children under 15 restrict their consumption of eight popular fish species (including walleye, yellow perch, and northern pike, with varying size ranges) to no more than one meal per month, due to mercury contamination.[10]

Mercury contamination is also a concern to the health of some fish themselves.

- Mercury has been shown to cause effects on behavior, development, growth and reproduction in fish, with impacts seen at levels as low as 0.2 parts per million (ppm).
- A review of mercury data for four sportfish species in the Great Lakes region indicated exceedance of the threshold effects level at 9 % of the sites containing

---

[7] Risch, M.R., Gay, D.A., Fowler, K.K., Keeler, G.J., Backus, S.M., Blanchard, P., Barres, J.A., Dvonch, J.T., 2012. Spatial patterns and temporal trends in mercury concentrations, precipitation depths, and mercury wet deposition in the North American Great Lakes region. *Environmental Pollution*, 161: 261-271.

[8] Atkeson T, Axelrad D, Pollman C, Keeler G. 2003. Integrating atmospheric mercury deposition and aquatic cycling in the Florida Everglades: an approach for conducting a total maximum daily load analysis for an atmospherically derived pollutant. Integrated summary, final report, Tallahassee, FL, Florida Department of Environmental Protection. Available from http://www.dep.state.fl.us/water/sas/mercury/docs/everglades_hg_tmdl_oct03.pdf..

[9] Mergler, D., Anderson, H.A., Chan, L.H.M., Mahaffey, K.R., Murray, M., Sakamoto, M., Stern, A.H. 2007. Methylmercury exposure and health effects in humans: A worldwide concern, *Ambio*, 33(1):3-11.

[10] Michigan Department of Community Health, Statewide Mercury Advisory fact sheet, and 2011-2012 Michigan Fish Advisory, available from http://www.michigan.gov/mdch/0,1607,7-132-54783_54784_54785---,00.html.

largemouth bass, and 26%, 38% and 45% of sites containing smallmouth bass, northern pike, and walleye, respectively. In some cases, substantial numbers of fish exceed a higher threshold (0.3 ppm), where effects on individual fish are more certain – for example, 46% of sites with northern pike in Michigan exceeded this higher threshold.[11]

Wildlife are at continuing risk from elevated mercury exposures in the Great Lakes region, including Michigan.

- Certain wildlife (including fish-eating species) are at particular risk, with potential impacts including physiological changes, aberrant behavior, and reproductive impacts.
- Common loons are often used as monitors of mercury contamination in ecosystems, though other bird species are actually more sensitive to mercury exposure, including species identified as having "moderate sensitivity" (e.g. Canada goose, ring-necked pheasant, and royal tern) as well as birds with "high sensitivity" (e.g. American kestrel, snowy egret and osprey).[12]
- In a recent synthesis of data for loons and yellow perch (their preferred prey), researchers identified seven mercury "hot spots" in the region, including one in the Upper Peninsula, and other areas in Michigan (particularly the U.P.) with elevated mercury levels that threaten reproductive success of loons.[13] The study found that nearly 10 % of modeled "male loon units" (areas of combined tissue types, territories and years) studied had mercury concentrations exceeding a low effects threshold, indicating the potential for population-level impacts.[14]
- Other wildlife species can be at risk from mercury exposure, including fish-eating mammals such as mink and otter[15] and even insect-eating songbirds.[16] There has been limited research addressing impacts to such species from mercury in Michigan, though a recent study of mink in Canadian shores of the lower Great

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[11] Sandheinrich, M.B., Bhavsar, S.P., Bodaly, R.A., Drevnick, P., Paul, E.A. 2011. Ecological risk of methylmercury to piscivorous fish of the Great Lakes region, *Ecotoxicology*, 20:1577-1587.

[12] Evers, D.C., Wiener, J.G., Driscoll, C.T., Gay, D.A., Basu, N., Monson, B.A., Lambert, K.F., Morrison, H.A., Morgan, J.T., Williams, K.A., Soehl, A.G. 2011. Great Lakes Mercury Connections: The Extent and Effects of Mercury Pollution in the Great Lakes Region. Biodiversity Research Institute. Gorham, Maine. Report BRI 2011-18. 44 pages.

[13] Evers, D.C., Williams, K.A., Meyer, M.W., Scheuhammer, A.M., Schoch, N., Gilbert, A.T., Siegel, L., Taylor, R.T., Poppenga, R., Perkins, C.R., 2011. Spatial gradients of methylmercury for breeding common loons in the Laurentian Great Lakes region, Ecotoxicology, 20:1609–1625.

[14] *Ibid.*

[15] Basu, N., Scheuhammer, A.M., Bursian, S.J., Elliott, J., Rouvinen-Watt, K., Chan, H.M. 2007. Mink as a sentinel species in environmental health, *Environmental Research*, 103:130–144; Martin, P.A., McDaniel, T.V., Hughes, K.D., Hunter, B., Mercury and other heavy metals in free-ranging mink of the lower Great Lakes basin, Canada, 1998–2006, Ecotoxicology, 20:1701–1712..

[16] See for example Rimmer, C.C., McFarland, K.P., Evers, D.C., Miller, E.K., Aubry, Y., Busby, D., Taylor, R.J., 2005, Mercury levels in Bicknell's thrush and other insectivorous passerine birds in montane forests of the northeastern United States and Canada, *Ecotoxicology*, 14:223–240; also Evers, D.C., A.K. Jackson, T.H. Tear and C.E. Osborne. 2012. Hidden Risk: Mercury in Terrestrial Ecosystems of the Northeast. Biodiversity Research Institute. Gorham, Maine. BRI Report 2012-07. 33 pages.

Lakes found that among 13 sites, the highest mercury concentrations were found in the Walpole Island delta region within the St. Clair River Area of Concern.[17]

Mercury: Trends

Mercury concentrations in fish and wildlife in the region have shown varying trends in the most recent data synthesis efforts. For example, while concentrations of mercury in largemouth bass in Ontario and U.S. waters declined from 1970 – 2009, walleye concentrations in Ontario began a trend reversal in approximately 1995-2000, and a similar trend reversal has been observed for northern pike in Minnesota lakes. A similar trend reversal has been observed in an analysis of loon mercury data for much of the region.[18] In any case, it has been noted that in general, mercury concentrations remain elevated above pre-industrial levels,[19] indicating the need for further reductions in mercury emissions in order to protect fish and wildlife.

Climate Change Threats to Fish and Wildlife in Michigan and the Great Lakes

Climate change threatens to bring a number of changes to the Great Lakes region, including warmer air and water temperatures, changes in precipitation patterns, increased storm flashiness, and changes in lake levels. A number of recent studies have identified how changes in climate are already affecting fish and wildlife in the region, and projections indicate potential threats going forward, including due to reduced habitat, northward range shifts, and climate-facilitated establishment of new invasive species. Recent research has indicated that terrestrial habitats and species are at risk from climate change.

- Moose increase their metabolic rate as temperatures rise, which adds stress that can affect survival. A study on northern Minnesota moose showed that mild winter temperatures explained the majority of variability in spring, winter, and annual moose survival, and that "continuation or acceleration of current climate trends will result in decreased survival, a decrease in moose density, and ultimately, a retreat of moose northward from their current distribution".[20]
- Small mammal communities have already experienced population shifts over the past few decades. A study of museum and other collection records showed that species of primarily southern distribution (e.g. white-footed mice and southern flying squirrels) have extended their range by over 140miles since 1980, and at specific sites in the U.P., the small mammal species groups have shifted from dominance by northern to southern species. Implications of these changes are not clear, but the authors note that small mammals are significant predators of seeds, bird eggs, and insects, dispersers of seed and fungi, prey for many carnivores, and

[17] Martin et al., 2011, *Op. Cit.*

[18] Evers, D.C. Wiener, J.G., Basu, N., Bodaly, R.A., Morrison, H.A., Williams, K.A. 2011. Mercury in the Great Lakes region: bioaccumulation, spatiotemporal patterns, ecological risks, and policy, *Ecotoxicology*, 20:1487–1499 (and references therein).

[19] *Ibid.*

[20] Lenarz, M.S., Nelson, M.E., Schrage, M.W., Edwards, A.J., 2009. Temperature Mediated Moose Survival in Northeastern Minnesota, *The Journal of Wildlife Management*, 73(4):503-510.

some species are potential hosts of disease (including hantavirus and Lyme disease).[21]

- Migratory birds may be at risk from climate change, due to climate-driven alterations in phenology patterns (e.g. arrival of migrants after earlier-than-usual tree leaf-out, seed production and insect emergence due to climate warming).[22] In addition, climate change could lead to northward migration of game birds such as ruffed grouse.[23]

In addition, the Great Lakes, their tributaries and other inland waters are at risk from climate change. Along with the record warm air temperatures of 2012, water temperatures in the Great Lakes were at record levels in July 2012.[24] Over the medium to longer term, climate change has a number of implications for the lakes, including changing patterns of water stratification and mixing, nutrient mixing, invasive species, and fisheries.

- Fish, including in streams and rivers, are threatened by climate change in the region. The summer 2012 heat wave has led to some fish kills in Michigan and elsewhere, though it has been noted that seasonal fish kills are not unusual events.[25] A more significant concern is the general warming of waters that would occur with longer term climate change. For example, a modeling study considering land use scenarios and a moderate climate change scenario in the Muskegon River watershed showed that warming water temperatures by the end of the 21st Century would reduce occurrence for cold water species studied, leading to virtual eradication of both brook trout and brown trout.[26]
- Ice cover is likely to continue to be affected in the region by further climate change. Studies have shown a shortening of periods of ice cover on inland water bodies and bays since measurements began, and rates of decline have been increasing in more recent decades,[27] with direct implications for ice fishing and other activities. A recent study of the Great Lakes themselves indicated declines in

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[21] Myers, P., Lundrigan, B.L., Hoffman, S.M.G., Haraminac, A.P., Seto, S.H., 2009. Climate-induced changes in the small mammal communities of the Northern Great Lakes Region, *Global Change Biology*, 15, 1434–1454.

[22] Kling, G.W., K. Hayhoe, L.B. Johnson, J.J. Magnuson, S. Polasky, S.K. Robinson, B.J. Shuter, M.M. Wander, D.J. Wuebbles, D.R. Zak, R.L. Lindroth, S.C. Moser, and M.L. Wilson. 2003. *Confronting Climate Change in the Great Lakes Region: Impacts on our Communities and Ecosystems.* Union of Concerned Scientists, Cambridge, Massachusetts, and Ecological Society of America, Washington, D.C.,http://www.ucsusa.org/greatlakes/glchallengereport.html.

[23] *Ibid.*

[24] Freedman, A., Great Lakes Water Temperatures at Record Levels, July 24, 2012, available from http://www.climatecentral.org/news/great-lakes-water-temperatures-at-record-levels/.

[25] Michigan Department of Natural Resources (MDNR), 2012. Extreme heat and drought causing fish kills, available from http://www.michigan.gov/dnr/0,4570,7-153--283060--,00.html; MDNR, 2012. Seasonal Fish Mortalities (Fish Kills), http://www.michigan.gov/dnr/0,4570,7-153-10364-119822--,00.html.

[26] Steen, P.J., Wiley, M.J., Schaeffer, J.S., 2010. Predicting Future Changes in Muskegon River Watershed Game Fish Distributions under Future Land Cover Alteration and Climate Change Scenarios. Transactions of the American Fisheries Society, 139(2):396-412..

[27] Kling et al., 2003. *Op. Cit.*; Jensen, O. P., Benson, B.J., Magnuson, J. J., Card, V. M., Futter, M. N., Soranno, P. A., Stewart, K. M. 2007. Spatial analysis of ice phenology trends across the Laurentian Great Lakes region during a recent warming period. *Limnology and Oceanography* 52(5): 2013-2026.

ice cover over the period 1973 – 2010 ranging from 37% in Lake St. Clair to 88% in Lake Ontario.[28] Declining ice cover has a number of implications, including for evaporation (and water loss), increased storm damage and erosion of in winter, and impaired spawning habitat for fish species such as lake whitefish.

- Water levels in the lakes will continue to vary, but climate change has the potential to lead to significant changes in the overall average. A recent paper considering a number of climate models and scenarios noted a wide range of potential water levels; however, one-quarter of the simulations showed that Lakes Michigan and Huron could decline as much as 0.76 m (30 in) by 2080.[29] While another recent analysis found that an alternative approach to estimating evaporation would lead to less dramatic declines than some of these other analyses have found,[30] there is still the potential for significant changes in water levels, with implications for coastal habitats (including wetlands) and numerous plant and animal species.
- The extent of hypoxia (low oxygen, or dead zones) in the Great Lakes could be exacerbated by climate change. Climate-driven factors (including the lengthening of summer stratification of water bodies, and thus increasing potential for oxygen depletion in the bottom waters during decomposition of dead algae and other organic material) can lead to increased hypoxia, with negative implications for some fish and other aquatic species. In addition, the extent of algal blooms could potentially increase, including due to longer ice-free periods and warmer water temperatures.[31]

The current review of climate change literature underway in the third National Climate Assessment will include a focus on the Midwest, with the potential to highlight additional research on recent and potential future changes affecting ecosystems in the region.[32]

Managing Risks from Energy Generation Technologies

All energy generation technologies have some environmental impact, and it is important to characterize impacts of all technologies in considering potential changes to the generation mix. One approach for comparing impacts of different technologies is via life cycle assessment, in which all aspects of the technology (e.g., construction of the generating plant, mining/extraction of fuels, operation of the facility, decommissioning, etc.) are identified and impacts integrated. This approach can be applied, for example, to assessing greenhouse gas (GHG) emissions of different technologies – as would be

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[28] Wang, Jia, Xuezhi Bai, Haoguo Hu, Anne Clites, Marie Colton, Brent Lofgren, 2012: Temporal and Spatial Variability of Great Lakes Ice Cover, 1973–2010*. *J. Climate*, **25**, 1318–1329.

[29] Angel, J. R., Kunkel, K. E. 2010. The response of Great Lakes water levels to future climate scenarios with an emphasis on Lake Michigan-Huron, *Journal of Great Lakes Research*, 36: 51-58.

[30] Lofgren, B.M., Hunter, T.S., Wilbarger, J. 2011. Effects of using air temperature as a proxy for potential evapotranspiration in climate change scenarios of Great Lakes basin hydrology, Journal of Great Lakes Research, 37:744-752.

[31] Kling et al. 2003, *Op. Cit.*

[32] U.S. Global Change Research Program, National Climate Assessment, information available from http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/midwest.

anticipated, studies have shown significantly reduced GHG emissions of renewable as compared to fossil fuel technologies, in particular coal-fired power plants. For example, a meta-analysis of 49 life cycle assessment studies of wind power found a median GHG emission value of 12 grams CO_2-equivalent per kilowatt-hour (g CO_2-eq/kWh), compared to approximately 1,000 g CO_2-eq/kWh for coal – i.e., approximately 100-fold reduced emissions for wind power.[33]

It is important to recognize that risks to fish and wildlife from energy generation will vary, depending on the technology used. For example, any power plant with cooling water intake structures will affect fish and other aquatic life (e.g., through entrainment and impingement of eggs, larvae, or individual fish). Data collected for the coal-fired Bay Shore power plant on Maumee Bay indicated over 208 million eggs and over 2.2 billion fish larvae entrained annually (the plurality freshwater drum).[34] For offshore wind generation, impacts to fish would not entail entrainment or impingement, but impacts to habitat could occur, including during installation and potentially during operation and decommissioning.

Impacts from development of any energy source (including both fossil fuel and renewable) need to be appropriately managed. For example, the country as a whole is expanding natural gas production, and much of the additional gas is being used in power generation. Though a cleaner fuel than coal, natural gas is still a fossil fuel, and significant quantities of greenhouse gases (in particular methane and carbon dioxide) are released to the atmosphere during production, processing, transmission and storage, distribution, and use.[35]

In addition to the GHG emissions from natural gas combustion, development of natural gas sources can lead to additional environmental impacts. Much of the recent increase in natural gas production has occurred via hydraulic fracturing ("fracking"), as technologies for horizontal drilling and fracturing of gas in shale "plays" (rock with significant natural gas accumulation) have advanced. Fracking poses a number of potential water quality and other concerns, including impacts to aquatic life from sediments and contaminants associated with fracking wastewater.[36] Production has increased significantly in the region (in particular in Pennsylvania, which has also experienced accidents such as spills and a gas well blowout),[37] and given the significant reserves in the Marcellus and Antrim

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[33] Dolan, S.L., Heath, G.A. 2012. Life Cycle Greenhouse Gas Emissions of Utility-Scale Wind Power: Systematic Review and Harmonization, *Journal of Industrial Ecology*, 16(S1):S136-S154.

[34] Ager, D.D., Marttila, D., Patrick, P. 2008. Bayshore power plant cooling water intake structure information and I&E sampling data. Kinectrics Report: 112026-005-RA-0002-R00.

[35] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2010, April 15, 2012, available from http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

[36] Entrekin, S., M. Evans-White, B. Johnson, and E. Hagenbuch.2011. Rapid expansion of natural gas development poses a threat to surface waters. *Frontiers in Ecology and the Environment* 9(9):503-511. http://dx.doi.org/10.1890/110053.

[37] Kirby, C.S., Marcellus Shale Environmental Impacts: Existing, Perceived, Potential, presented at CEREL Conference, West Virginia University, November 8, 2011, available from http://ncseonline.org/sites/default/files/Kirby.pdf; also see Commonwealth of Pennsylvania, Department of Environmental Protection (DEP), news release, October 22, 2009, available from http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=2399&typeid=1, and

shale plays (nearly 2/3 of the lower 48 shale gas resources are in the Northeastern U.S., including Michigan),[38] production in the region will likely be increasing even more in the years ahead.

This rapid development has been accompanied by increasing regulatory attention at the federal, state and local levels. Both Ohio and Pennsylvania recently passed amendments to laws governing oil and gas development. In Michigan, where gas production from the Antrim formation (mostly through vertical drilling) has been occurring for over two decades, most production activities are covered through Part 615 of the Natural Resources and Environmental Protection Act. Provisions address aspects such as permitting for well drilling, casing installation, disclosure of information on fracking fluids, and requirements for waste disposal wells, provisions similar to those adopted in Ohio. Michigan also issued a new permitting instruction in 2011, which included requirements for use of a water withdrawal assessment tool and addressing any impacts found to adjacent freshwater wells. Approaches to managing fracking in the Great Lakes states (with a focus on Michigan and Ohio) were recently described in an NWF report.[39]

As with natural gas drilling, the management and regulation of wind turbine siting and operations have already become more sophisticated and will be even more so as substantially more turbines are proposed and sited. Regarding impacts to fish and wildlife from renewable energy sources such as wind, while it is clear that there are outstanding research needs (including more information on potential wind farm impacts on bats, more comprehensive information on migratory species in general, as well as impacts of large numbers of turbines near stopover sights for migratory species), siting guidelines have been developed to minimize impacts based on existing information (including through agency and NGO efforts),[40] and such guidelines can be revised as new information becomes available. Creation of a regulatory framework for increased development of wind energy in Michigan (and elsewhere) can be done in a way that protects natural resources around wind development areas while contributing to broader and longer term protection of the state's natural resources.

Commonwealth of Pennsylvania, DEP news release, June 7, 2010, available from http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=11925&typeid=1.

[38] U.S. Energy Information Administration, Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays, July 8, 2011, available from http://www.eia.gov/analysis/studies/usshalegas/.

[39] Gosman, S., Robinson, S., Shutts, S., Friedmann, J., 2012. Hydraulic Fracturing in the Great Lakes Basin: The State of Play in Michigan and Ohio, National Wildlife Federation.

[40] See for example U.S. Fish and Wildlife Service, U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines, March 23, 1012, OMB Control No, 1018-0148, available from http://www.fws.gov/windenergy/docs/WEG_final.pdf; Ontario Ministry of Natural Resources, Birds and Bird Habitats: Guidelines for Wind Power Projects, First Edition, December 2011, available from http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@renewable/documents/document/stdprod_071273.pdf; Ewert, D.N., Cole, J.B., Grman, E., 2011. Wind Energy: Great Lakes Regional Guidelines. Unpublished report. The Nature Conservancy, Lansing, MI, available from http://conserveonline.org/library/wind-energy-great-lakes-regional-guidelines/view.html.

4/25/13

Rationale for Building a Photovoltaic Infrastructure

One of the more challenging aspects of the photovoltaic business is conveying the rationale for pursuing the undertaking at all. To our potential customers we show realistic payback projections involving power costs as they look now and as they might look over the next few decades. To utilities and policy makers who shape our industry with incentives we demonstrate the need for investing in an infrastructure that currently does not generate power competitively but that will ultimately serve as the platform for sustainability.

The investment in solar infrastructure is best viewed in a longer run analysis that takes into consideration rising energy costs, diminishing fuel sources and increasing demand for non-polluting energy sources. It takes five years of solar production to repay the energy invested in the manufacture of a photovoltaic array and at first glance this seems absurd. But another way of viewing this fact is that a photovoltaic array with a proven and warranted production life of 30 years will produce six times the energy it took to manufacture it over its lifespan.

From the viewpoint of sustainability there is a potential that with enough forward investment at a time when fossil fuels are still readily available and relatively inexpensive we could create a self-sustaining power supply that can power the manufacture of more of itself and still have power to supply our consumption.

Power storage is the largest barrier to this model at this time and it may take a decade or two to develop the technology to store large quantities of power in an efficient manner. The rationale for investing in solar infrastructure now is that there is an enormous energy investment to build the capacity of generation we need and we can't wait until we have the storage technologies in place to start building that capacity. It would be impossible to burn that much fossil fuel that quickly. We need to build this infrastructure over time and now is the time to begin taking this job seriously.

From: Jan Wright <janwrigh@umich.edu>
Sent: Wednesday, April 24, 2013 10:32 AM
To: Energyinfo
Subject: Another issue that needs addressing

Dear Director Bakkal and Chairman Quackenbush,

Thank you for all the effort you have put in to gathering input for the Governor's energy plan, especially your presence at the seven forums held across the state. **I am concerned, however that one major issue is missing,** at least in the forum I attended, the video clips I viewed and the questions on the energy website.

What about climate change? Granted it cannot be contained within Michigan's borders and we cannot regulate it as we can renewables, efficiency, choice, etc. But it will have effects on our jobs, health and economy, even if we choose to ignore it.

Michigan will be affected by climate change, no matter what energy decisions we make, but we have some choice about whether the effects are just troublesome, seriously problematic, or catastrophic. **A major increase in the use of renewable energy and energy efficiency and a corresponding cut in our use of coal would help prevent the following problems** that are already beginning to affect our state and will become worse.

I know the Governor wants data, and rightly so. The information cited below is based on recent data. See the *Midwest chapter of the **National Climate Assessment**, January 2013 (draft); http://ncadac.globalchange.gov]*

> "Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure."
>
> Temporarily increased yields of some crops in the short term "will be increasingly offset by the occurrence of extreme events such as heat waves, droughts, and floods."
>
> "In the long term, combined stresses associated with climate change are expected to decrease agricultural productivity, especially without significant advances in genetic and agronomic technology."
>
> In the Great Lakes region, climate change will exacerbate a range of risks, including
>
> - changes in the range and distribution of important commercial and recreational fish species,
> - increased invasive species,
> - declining beach health,
> - harmful blooms of algae.
>
> "Increased heat wave intensity and frequency, degraded air quality, and reduced water quality will increase public health risks."

These seem to me extremely good reasons to move to more renewables and energy efficiency and far less use of coal, which contributes greatly to climate change.

What about natural gas? Many people are looking to natural gas "fracked" from shale to solve some of our energy problems or at least to use as a bridge fuel as we transition to non-fossil-fuel sources of energy. I have major concerns about this as well, in terms of contributing to climate change. Researchers are raising serious questions about how clean this energy source really is as well as what risks it raises to our water, our health and our economy. For example:

> "For most uses, the GHG [greenhouse gas] footprint of shale gas is greater than that of other fossil fuels…." and "shale gas is not a suitable bridge fuel for the 21st Century." (Cornell University researchers) Howarth, R. W., R. Santoro, and A. Ingraffea. 2012. Venting and Leaking of Methane from Shale Gas Development: Response to Cathles et al. Climatic Change. In Press.

In addition, even though natural gas burns cleaner, all the fossil fuel needed to extract, process and transport this kind of gas makes is so carbon-intensive that some say it compares to coal in its harmful effects on the climate.

While we are causing more than our share of the problem, we also have the potential to contribute significantly to the solution. Also from the ***National Climate Assessment:***

> "The Midwest has a highly energy-intensive economy with per capita emissions of greenhouse gases more than 20% higher than the national average. The region also has a large, and increasingly utilized, potential to reduce emissions that cause climate change."

As you are developing the energy plan for our future, please don't just think narrowly about immediate financial costs and the short-term future—think about broader implications, so we really do have "no regrets for our future!"

Thank you.

Sincerely,

Jan Wright, Chair, Climate Change and Earth Care Task Force

Interfaith Council for Peace and Justice

From: Diane LaBate <zasha2@verizon.net>
Sent: Tuesday, April 23, 2013 7:55 PM
To: Energyinfo
Subject: Governor's MI Energy Public Form Comments

*Comments made at the **Governor's Michigan Energy Public Forum***

Monday, April 22, 2013

Northwestern Michigan College, Traverse City, MI

By Henry LaBate, retired nuclear engineer

799 Minkin Drive, Traverse City, MI 49685

231-709-8839

Concern: CARBON POLLUTION AND THE UNINFORMED CITIZEN

*All the discussions/presentations today are based on reduction of carbon (CO2) pollution.

* Most attending today do not appear to understand what the CO2 concentration in the atmosphere is!

* 40 US Congressional energy staffers surveyed could not come close to stating CO2 concentration in the atmosphere. During a phone call I had with Michigan Senator Carl Levin's energy staffer, last year, said that CO2 was 40% of the atmosphere! Also in a phone call I had last year with the NRDC (Natural Resource Defense Council) climate scientist, in NYC, she admitted she did not know what the CO2 concentration in the atmosphere is. She also was unaware that CO2 has been 18 times its present level during dinosaur periods.

* CO2 is not increasing so fast that one presenter could not keep up with it and the earth CAN support life with CO2 above 350 PPM! By the way, 350 parts per million is 0.035% of the atmosphere. CO2 IS A TRACE GAS!

*** FACT ABOUT CO-2:** It does not matter if you believe that CO2 is the cause of some nebulous, loosely defined global warming/climate change theory or not. You cannot reduce CO2 below 350 PPM as one presenter demanded. If we took all automobiles away from everyone, there would be no measurable reduction in atmospheric CO2. Man contributed an estimated 10 PPM of the 390 PPM currently China, India, Brazil and other developing nations installing relatively dirty coal power plants will completely overwhelm efforts to "reduce our carbon footprint" in both the US and EU. This is why the Senate rejected VP Gore's agreed to 1998 Kyoto Treaty 98 to 0. What has changed? Volcanoes, however, has and will negate all of the world's efforts to reduce "carbon footprints".

* Wind power is inefficient, as extensively addressed in the UK paper "The Trouble with Wind Power" readily found on the internet. Many EU nations are reducing their reliance on wind power because of the unreliability and the very expensive need for back up (usually coal/oil/gas) base power systems up and running (and polluting?) waiting for the wind to die down to flip the switch. It is too expensive to purchase both and not get any "environmental" advantages.

* The Michigan Land Use Institute (MLUI) presented a summary of an energy survey which was slanted in that it started with an agenda, leading questions and excluded two excellent energy sources for Michigan residents to choose; specifically MLUI purposely ignored Geothermal heat pumps (used frequently in northern Michigan and usable in 70% of the US, including Alaska); and they ignored hydro- electric (arguably the lowest cost energy) since they were prominent in the Agenda 21 effort to remove all dams such as the Boardman River fiasco in Traverse City. (I called the MLUI to advise them of the above flaws but comments were not favorably received.)

<u>* RECOMMENDATION:</u> The model I would suggest for how conservation groups and industry should interact is the efforts of the *Anglers of the Au Sable* (as noted in their Winter 2011 Quarterly Newsletter, "THE RIVERWATCH) took to protect the Au Sable watershed against an oil pipeline massive leak as was experienced in the Kalamazoo River in 2010. We need to work with our current energy needs as we build towards our future energy resources. The Enbridge Pipeline oil company, The Anglers of the Au Sable, the County and township emergency management and fire departments met a month after the Anglers requested a meeting and subsequently had disaster dry runs and hot runs to establish plans and resources for a worst case disaster of protection of the environment . This interaction also identified a need for an additional (very expensive) automated valve which was installed by Enbridge Corp. All this was accomplished with local resources and planning. They didn't need the Federal or State government or more importantly THE COURTS. Many environmental groups attending today should learn from this example.

* **<u>I encourage CRITICAL THINKING</u>** by everyone on energy issues. <u>We need to find ways to have a vibrant economy while rationally protecting the environment</u>. In the 1970's and before had the scourge of rivers on fire and acid rain killing the fish in north east US lakes. Let's take credit for what we have accomplished.

Readying Michigan to Make Good Energy Decisions

Comments of Wind on the Wires Regarding the Renewable Energy Standard

Prepared by:
Sean R. Brady
Christopher Zumski Finke

April 25, 2013

EXECUTIVE SUMMARY

There are sufficient wind energy resources to meet a sizable increase in the renewable energy standard ("RES") in Michigan. Michigan has resources within the state to meet a higher standard and has access to cost effective renewable energy resources in MISO to provide energy to Michigan ratepayers. Increasing the RES will diversify an electricity provider's energy portfolio to act as a hedge against potential fossil fuel volatility. Wind energy prices from 2011-2012 (inclusive of the production tax credit) will likely drop in the near term due to advances in turbine technology, wind forecasting and the use of dispatchable intermittent resource technology. Those wind energy prices will perform as a hedge against potential fossil fuel volatility over the next twenty years. They act as a hedge since they are lower than a large percentage of potential future costs of natural gas over the next twenty years and lower than the levelized cost of new natural gas plants inclusive of their fuel price volatility over the same period.

Wind energy reliability is improving and will continue to be reliable due to the advances in turbine technology, in wind forecasting and in the use of dispatchable intermittent resource technology.

Another factor that should be considered when increasing the RES is the locally distributed benefits wind energy provides. Wind energy provides local benefits across Michigan in the form of royalty payments to landowners, property tax payments to Townships who can then use that money to pay down debt, and pay for local schools and roads.

STRUCTURE OF THE COMMENTS

This comment is limited to the renewable energy standard, and is structured to address two of the three main topics identified by the Commission and Department of Energy – affordability and reliability of wind energy. The issues of affordability and reliability are characteristics of a well-designed renewable energy standard. These points are therefore sub-ordinate to a more fundamental question – *what are the facts supporting the need for changing – in effect increasing – the renewable energy standard*?

The comments start with that fundamental question, then address issues related to affordability, reliability, other benefits of wind energy as part of a renewable energy standard and concludes with a section responding to some of the common wind issues raised by speakers at the public hearings. While this last section is not part of our main comments, we thought it would be useful for the Commission and the Department of Energy, to the extent a party raised a topic upon which you'd like to understand the wind industries perspective.

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COMMENTS

1. Facts Supporting the Need to Increase the RES?

The issues outlined by the Governor – affordability, reliability and environmental impact – all relate to the capability of wind energy to meet an increased RES. Before we address those issues we first need to evaluate some of the factual reasons for increasing the RES. The quick answer is that fossil fuel generation poses a certain level of harm to the environment, there is only a certain volume of available fossil fuels to be consumed, costs of fossil fuel will continue to increase as its volume decreases and fuel costs will likely increase between now and the end of the century. Therefore, Michigan needs to **take a long term approach** to its electricity policy, an approach that spans the remainder of this century.

Increasing the percentage of renewable energy capacity in the generation portfolio of Michigan electric providers will increase its diversity. Diversity acts as a price hedge against fossil-fuel price volatility. Increased use of renewable energy resources will reduce the pollutants that cause adverse public health issues, can create new opportunities for new businesses within Michigan and extend the usable life of fossil fuels. Moreover, utilities are unlikely to change their business-as-usual activities without a strong message from the public, and guidance and assurance from legislators.

Increasing the RES will continue to inspire growth within Michigan. The manufacturing base for renewable energy components that has grown within Michigan since 2009 will continue to grow with an increased RES. Increasing the RES that has an in-state requirement will bring new tax dollars from windfarms into Michigan. Windfarms are built over a large area and typically pay taxes in multiple townships. Those payments have been used by some townships and counties to pay off debt, cover increasing costs of schools and keep residential property taxes low. Windfarm developers also make royalty payments to farmers and property owners for the use of their land. Those payments provide a known revenue stream for farmers over the next 20 years that they can use to buy materials they need to plan and operate their farm.

Changing the RES affects the electric service providers/utilities of Michigan. Like most business they require a known level of stability to be able to manage risk and continue operations. Establishing a long-term RES policy provides certainty and stability for electric providers, which helps identify its risk exposure – an aspect of keen interest to stakeholders and financial ratings houses. Therefore, an informed and transparent increase in the RES allows the electric providers to evaluate the impact of the RES and determine how to manage the transition to a more diversified energy portfolio.

2. If the RES is Increased – What is the Capability of Wind Energy to Meet that Increase?

The most recent value for Michigan's total retail sales is the Michigan PSC Annual RES Report from February 2013. That report shows that Michigan consumers use approximately 102,689,787 MWhs. A rough approximation of the current RES requirement is 10% of energy delivered to consumers, which would be approximately 10,268,979 MWhs.[1]

A. From Within Michigan

The Wind Energy Resource Zone Board identified 4 potential wind energy zones. The Board estimated that those zones could produce between 9.9 million MWhs and 17.7 million MWhs of renewable energy. That is between 9.5% and 17% of Michigan's renewable energy standard.[2]

EXHIBIT 3
Estimated Minimum and Maximum Number of Turbines, Capacity, and Annual Energy Production, by Identified Region

		Minimum			Maximum		
Region	Counties	Number of turbines	Capacity (MW)	Annual energy potential (MWh)	Number of turbines	Capacity (MW)	Annual energy potential (MWh)
1	Allegan	166	249	747,938	296	445	1,338,415
2	Antrim Charlevoix	102	153	439,555	183	274	786,572
3	Benzie Leelanau Manistee	435	652	1,991,679	778	1,167	3,564,058
4	Huron Bay Saginaw Sanilac Tuscola	1,578	2,367	6,723,472	2,824	4,236	12,031,477
TOTAL		2,281	3,421	9,902,644	4,081	6,122	17,720,522

SOURCE: Research and findings from Michigan State University Land Policy Institute, 2009, prepared for WERZ Board.

NREL has estimated the available windy land in Michigan at various turbine heights and wind capacities. From that estimate NREL calculated the potential wind energy that could be

[1] Michigan PSC, *Report on the Implementation of the PA 295 Renewable Energy Standard and the Cost Effectiveness of the Energy Standards*, Appendix B (2/15/2013).
[2] *Final Report of the Michigan Wind Energy Resource Zone Board* at 5.

produced within the state. The most conservative of those estimates is the estimate from windy land with a capacity factor greater than 30% at a turbine height of 80 meters ---

	Windy Land Area >= 30% Gross Capacity Factor at 80m	Wind Energy Potential	
State	Available % of State	Installed Capacity[3] (MW)	Annual Generation (MWh)
Michigan	**7.85%**	**59,042.3**	**169,221,000**

SOURCE: NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011).

Therefore, if only 10-20% of the windy available land (approximately 0.8% to 1.2% of available land in Michigan) is utilized by windfarms in Michigan, the state could achieve an RES of 15% to 30% of its total electricity demand in Michigan in 2010.

B. From Outside of Michigan

While Michigan appears to have sufficient renewable resources to provide more than 10% of the electricity demand, neighboring states and MISO states have plenty of wind energy for Michigan to draw upon. If Michigan were to expand the geographic location of renewable energy sources that could be used to meet the RES, it could easily use wind energy sources to provide 25-30% of its energy demand with 0.15% to 0.2% of the wind energy potential from Ohio and states within the Midwest Independent System Operator ("MISO") footprint.

State	**Wind Energy Potential Annual Generation (MWh)**
Michigan	169,221,000
Indiana	443,192,000
Ohio	151,881,000
Illinois	763,529,000
Wisconsin	300,136,000
Minnesota	1,679,480,000

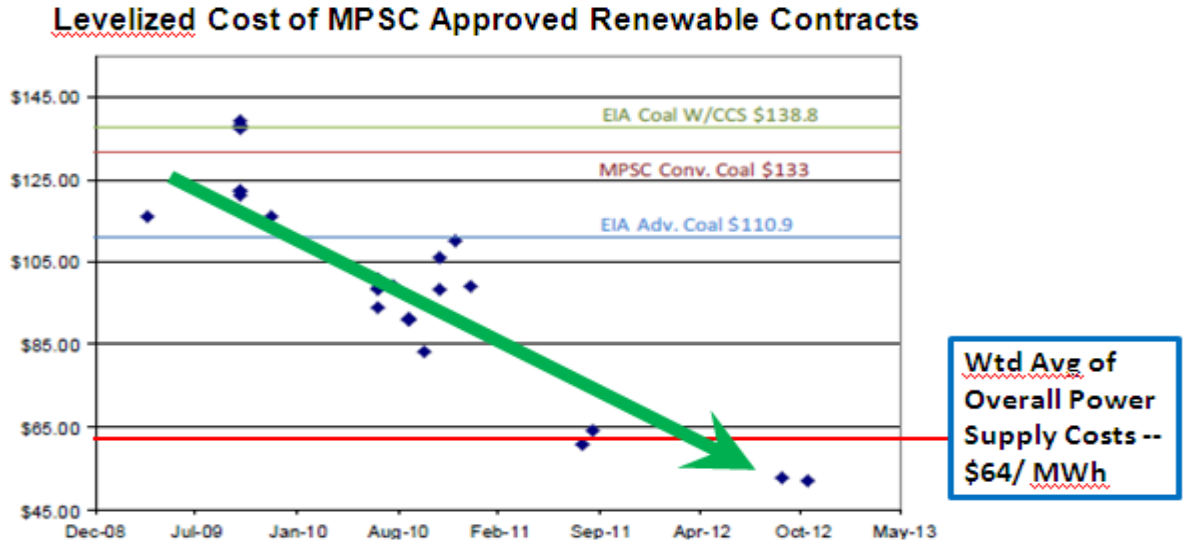
Iowa	2,026,340,000
North Dakota	2,983,750,000
South Dakota	3,411,690,000
Missouri	810,619,000
Montana	3,228,620,000
TOTAL:	**15,969,178,000**
0.2% of Total:	**31,938,356**

SOURCE: NREL, *Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factors at 80m* (April 13, 2011).

3. AFFORDABILITY: What Would be Wind Energy's Cost?

A. Wind Energy Prices in Michigan Since 2008

Since the start of the Renewable Energy Standard in 2009, the price for wind energy has dropped (an explanation of why prices have dropped is provided *infra,* at *'Wind Energy Costs Have Dropped Since 2009 and are Forecasted to Stay Low'*). Contracts entered into in the last three years have been under $65, and lower than the current average power costs of Michigan utilities.[3]



[3] See Michigan PSC, *Report on the Implementation of the PA 295 Renewable Energy Standard and the Cost Effectiveness of the Energy Standards* at 30 (2/15/2013).

Therefore, the trend since 2011 is that utility scale wind contracts are less than what ratepayers are paying for electricity. This indicates that it can provide a hedge against fuel price volatility of the utilities' current energy generation portfolio.

B. Levelized Cost of Energy: Comparing Wind Energy to Other Primary Sources of Generation

Generating plants generally have an operating life of twenty to fifty years. Within two to three generating plant generations, Michigan will be in the year 2100. Michigan, therefore, needs to take a long-term view of its electricity generating portfolio. Consumption of coal and natural gas over the next 90 years will cause the cost of these fuel sources to increase. Growth in demand is around 1-2%, and that growth rate doesn't necessitate the need for new plants. Plants will be built to replace existing plants. Therefore, there will be few opportunities to build new, large generating plants over the next 90 years. Michigan needs to start assessing today what it wants its energy portfolio to be 50 to 90 years from now.

In considering whether to increase the RES, Michigan should look at the potential long term cost of wind energy with respect to other forms of generation. Consumers Energy and Detroit Edison's customers consume over 73% of the electricity used in Michigan.[4] Their current energy generation portfolios are comprised of the following generating sources and plant age:

Consumers Energy

Source	% of Nameplate Capacity	Age
Coal	38%	32-60 y.o.; avg = 52 yrs
Natural Gas/Oil	36%	11-37 y.o.; avg = 20 yrs
Hydro/Pumped Storage	26%	47-106 y.o; avg =

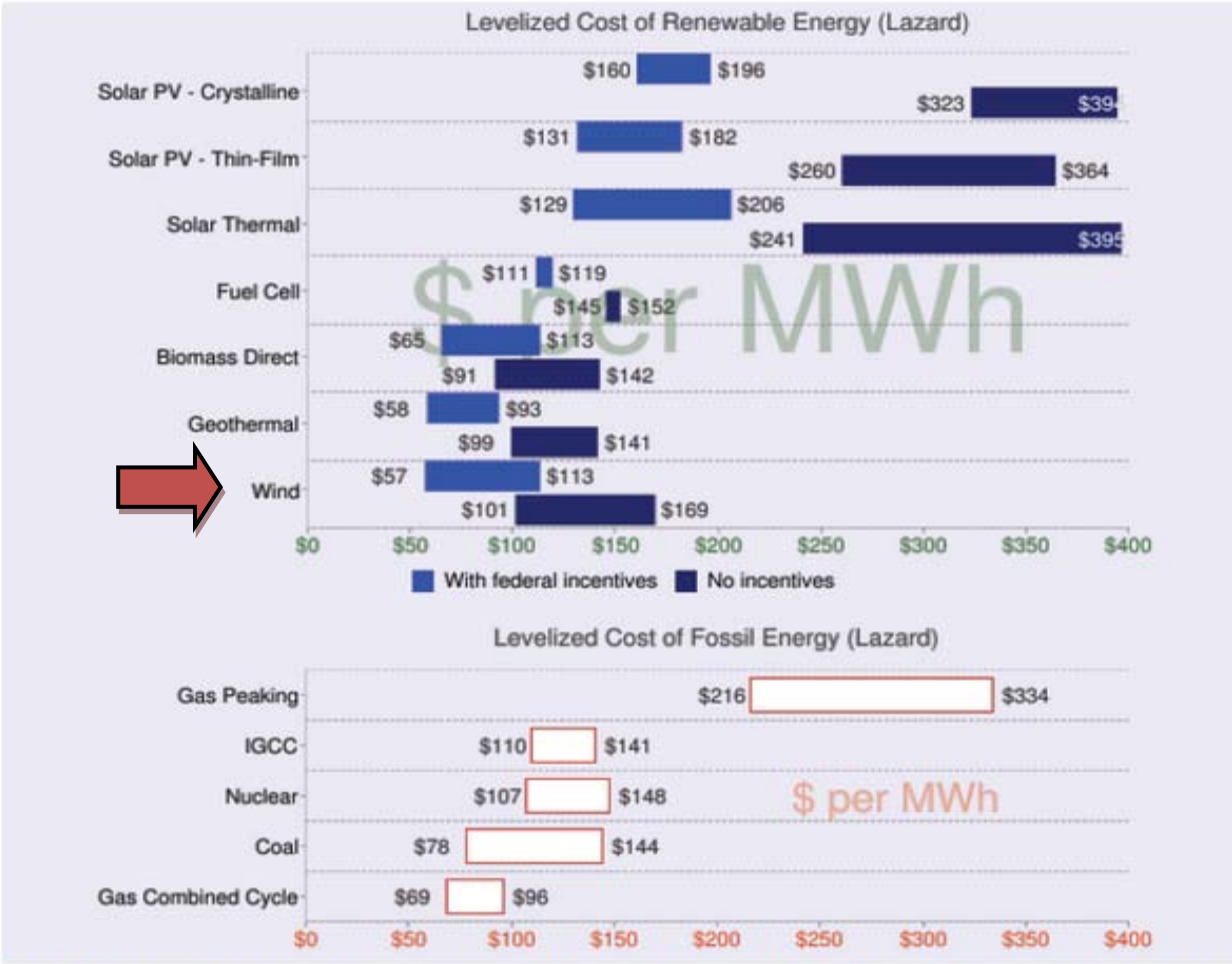
[4] Michigan PSC, *Report on the Implementation of the PA 295 Renewable Energy Standard and the Cost Effectiveness of the Energy Standards* at Appendix B (2/15/2013).

Detroit Edison

Source	% of Generating Capacity	Age
Coal	75%	28-69 y.o.; avg = 50 yrs
Nuclear	20.3%	
Natural Gas	2.5%	

SOURCE: Consumers Energy Electric Generation data, available at http://www.consumersenergy.com/content.aspx?ID=1373; Detroit Edison Fuel Mix, available at http://www.dteenergy.com/dteEnergyCompany/environment/generation/fuelMix.html

Based on this data, new generating plants will need to be built in the relatively near term. In evaluating the long term costs of energy, Michigan should compare the levelized cost of wind energy to that of existing natural gas plants and that of new natural gas, coal and nuclear plants. There are a number of firms that publish levelized cost of energy ("LCOE"). Below is a table whose numbers are out-of-date, (reflecting levelized costs calculated with 2009 data), and more recent LCOE studies will show that the cost of wind has dropped since 2009. Nonetheless, the graph below reflects the relative comparison of onshore wind (with and without the production tax credit) to natural gas (i.e., Gas Combined Cycle, in the chart), coal and nuclear:



These figures don't even take into account the environmental and social "value" of renewable electricity.

SOURCE: Stephen Lacey, "*Where Renewables Stack Up: Comparative Chart on Levelized Cost of Energy and the "Value" of Clean Energy*" (6/24/2011), available at http://thinkprogress.org/climate/2011/06/24/253357/where-renewables-stack-up-comparitive-chart-on-levelized-cost-of-energy-and-the-value-of-clean-energy/

More recent levelized cost of energy reports have been prepared by Bloomberg[5] and Lazard[6].

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[5] *Sustainable Energy in America 2013 Factbook*, by Bloomberg (Bloomberg Finance LP and the Business Council for Sustainable Energy, *Sustainable Energy in America 2013 Factbook*, at 14 (January 2013), *available at* http://www.bcse.org/sustainableenergyfactbook.html

[6] *Levelized Cost of Energy Analysis – version 6.0*, by Lazard (Lazard, *Levelized Cost of Energy Analysis – version 6.0*, (June 2012), *available at* https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2012/20121221/20121221%20PAC%20Supplemental%20Levelized%20Cost%20of%20Energy%20Analysis.pdf).

C. Wind Energy Provides a Long-term Cost Benefit – Acting as a Hedge to Increasing Natural Gas Prices

Natural gas is coming off a ten year low price in 2012 of approximately $2.79/ thousand cubic feet (U.S. E.I.A., Natural Gas Data, Electric Power Price (4/2012)) and the use of hydraulic fracturing to recover natural gas has many people touting it as a long term solution to energy needs in the United States. However, natural gas prices have increased. They are now above $4.50/ thousand cubic feet, and we know its price is volatile. A large supply of natural gas generation will leave Michigan exposed to that volatility.

A recent study performed by Lawrence Berkeley National Laboratory[7] ("LBNL") is informative on this point. Herein, I will briefly summarize their work. The graph below uses the average wind energy price in 2011-2012. This is important because those are the most recent prices and reflect the changes in wind turbine technology that have reduced the overall capital cost of wind turbines. The average price of wind energy power purchase agreements (for twenty years) executed in 2011 and 2012 in the United States is in the mid-$40s per megawatt hour.

The graph compares the 2011-2012 average wind energy price to the range of high and low estimated natural gas prices as forecasted by the U.S. E.I.A. in its Annual Energy Outlook reports for 2011, 2012 and 2013. That range is represented by the light blue shaded area. The high and low estimates provide a range of 95% probability for natural gas prices over the next twenty years. The cost of fuel is approximately 70% of the operating cost of a natural gas plant.[8] The light blue shaded area shows that the forecasted natural gas fuel prices over the next 20 years will continue to increase. The fact that a significant portion of the light blue shaded area will surpass the average wind energy prices of 2011-2012 – which is in the mid-$40 range – indicates that wind energy at current prices provides a good hedge to future natural gas prices.

While LBNL's report is only in draft form, here are the conclusions it has made regarding the graph shown below:

> Figure 9 shows that these recent wind PPA prices are quite competitive with natural gas fuel cost projections. The average wind PPA price holds steady in the mid-$40/MWh range, and by 2022 lies below all three reference case gas price projections, eventually falling outside of the

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[7] Mark Bolinger, LBNL Draft Report: *Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices* (March 2013)

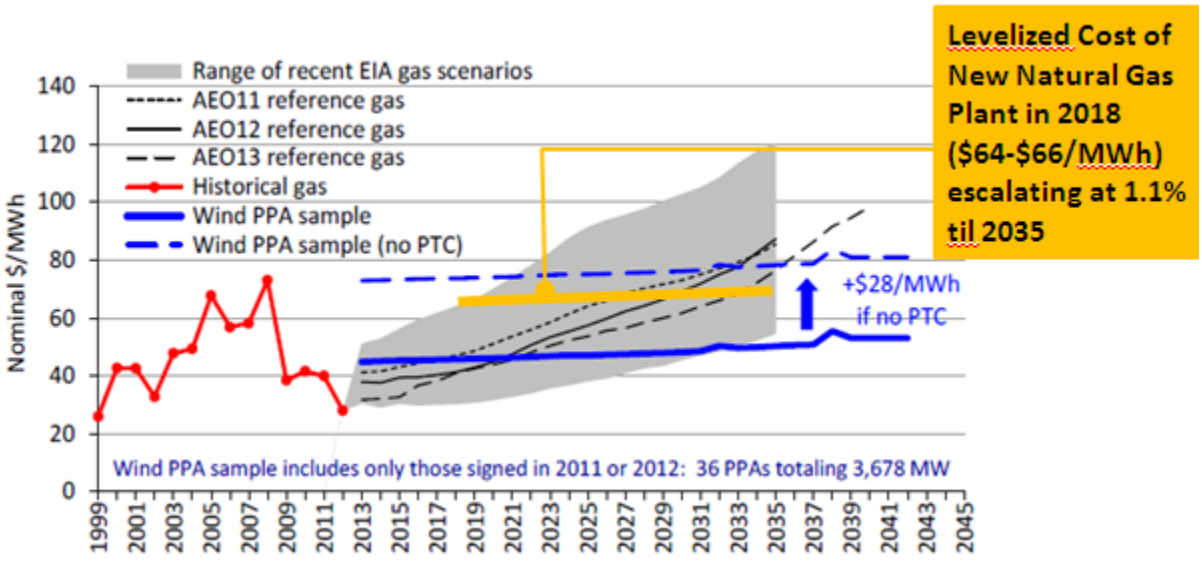
[8] The LCOE projections for conventional and advanced combined cycle natural gas plants estimate fuel to be 71% and 68%, respectively, of the total system levelized cost. *See* U.S. Energy Information Administrations, *Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013*, at 4 (January 2013).

cone of uncertainty altogether in 2033. In other words, not only do these recent wind PPAs provide ample long-term hedge value, but they are also, on average, competitive natural gas fuel savers in the near-term when compared to reference-case natural gas price projections for the U.S. as a whole.

. . .

In summary, Figures 8 and 9 demonstrate that – even in today's low gas price environment, and with the promise of shale gas having driven down future gas price expectations – wind power can still provide protection against many of the higher-priced natural gas scenarios contemplated by the EIA. This is particularly true among the most recent PPAs in the LBNL sample, which likely better represent current wind PPA pricing, at least on a national average basis. These newer wind contracts not only provide ample long-term hedge value, but on average are also directly competitive as a natural gas fuel saver (at least when compared to reference-case gas price projections) in the near term. Without the benefit of the PTC, wind's near-term competitiveness is challenged, but long-term hedge value still remains.

SOURCE: LBNL Draft Report: *Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices* at 21.



SOURCE: LBNL Draft Report: *Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices* (March 2013); U.S. EIA Levelized Cost of New Generation Resources (January 2013))

I have added to the graph a comparison of average wind energy prices for 2011-2012 to that of new natural gas plants. The orange line represents the levelized cost of new natural gas plants which could be built to replace coal plants that are retired. This is relevant since Consumers Energy, in December 2012, announced its interest in building a major new natural gas fired power plant in Genesee County. The company estimates it will invest about $750 million in the project. The average wind energy prices of 2011-2012, represented by the solid blue line, are lower than the levelized cost of new natural gas plants. Therefore, wind energy can serve as a hedge against the cost of new natural gas plants.

Even if the production tax credit is no longer offered, wind energy remains competitive with natural gas prices from existing or new plants, just over a longer period of time. The blue dashed line represents the average wind energy prices of 2011-2012 without the PTC. The average wind energy prices of 2011-2012 without the PTC are slightly higher than the levelized cost of new natural gas plants.

A portion of the forecasted gas prices, represented by the gray shaded area, is above the blue and blue dashed lines. This indicates a likelihood that natural gas prices will be greater than the average wind energy prices of 2011-2012 with or without the PTC. Therefore, accepting the proposition that wind energy prices will not increase above its 2011-2012 prices for the next five to ten years, wind energy will be cost competitive with electricity prices from existing and new natural gas plants over the twenty year term of the power purchase agreement and therefore will generally act as a hedge against the increase in natural gas prices.

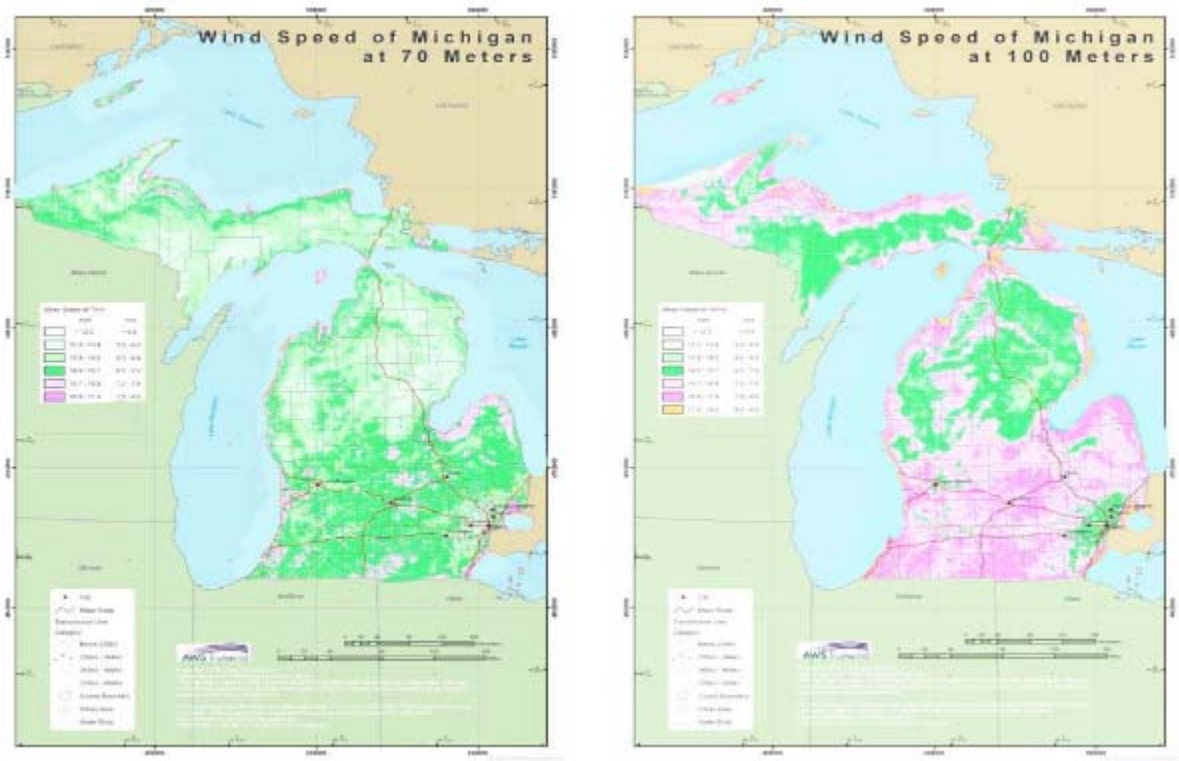
D. Wind Energy Costs have Dropped Since 2009 and are Forecasted to Stay Low

Advances in turbine technology have allowed wind developers to cut their rates for wind energy.

> Global turbine prices declined by roughly 40% over 2009-12. Keeping all other cost components equal, a 40% decline in turbine prices equates to a roughly 22% decline in the levelized cost of electricity (LCOE) for wind. Turbine performance has also improved, particularly for those purposed for low wind speeds. A 5% improvement in capacity factor, from an average of 30% to an average of 35%, drives down the LCOE of wind by roughly 13%. **The combined effect of a 40% decline in turbine prices and a 5% improvement in capacity factor yields more than a 30% decline in the average LCOE of wind energy.**

(Bloomberg Finance LP and the Business Council for Sustainable Energy, *Sustainable Energy in America 2013 Factbook*, at 14 (January 2013), *available at* http://www.bcse.org/sustainableenergyfactbook.html) (emphasis added).

In the past few years, wind developers have been building windfarms in areas with lower wind speeds. Several factors may be driving his trend – increased availability of 'low-speed' turbines and use of towers above the 70 meter height. A wind turbine's ability to generate power at lower wind speeds has enabled developers to build in a wider range of locations that have other benefits, such as close proximity to existing transmission lines. Similarly, higher towers allow the turbines to access higher wind speeds in areas within close proximity of existing transmission lines.[9] Below is a side-by-side comparison of wind speeds in Michigan at the 70 meter height and the 100 meter height. This comparison shows how much more land in Michigan could potentially be developed with a higher turbine or a low-speed turbine.



The pink areas reflect higher wind speeds. While wind turbines can be made to operate more effectively in certain wind speeds, generally, a turbine has a greater generation capacity at

[9] U.S. D.O.E., Energy Efficiency and Renewable Energy, *2011 Wind Technologies Report*, at 45 (August 2012).

higher wind speeds. At 100 meters, Michigan has economical wind in 60% of its' total land area. This also makes it easier for Michigan to reach a 25% or 30% renewable energy standard with in-state wind development, since only 0.8% to 1.2% of Michigan's available land would need to be used to reach such goals.

4. RELIABILITY: What Would be Wind Energy's Reliability?

A. Wind Energy Production is Predictable Relative to Other System Operations or Outages

Wind speed changes relatively slowly and is predictable. Windfarm owners/operators use models/programs to predict wind speed. Industry experts expect the models to continue to improve as more data becomes available and programs become more sophisticated.

Wind speed changes occur more slowly than changes in electricity supply, demand or a plant outage. Therefore, wind is no less reliable than the current operation of the grid that the transmission system operator has to manage.

Windfarms have numerous turbines, so electricity is being produced even if one turbine is not operating. In contrast to a centralized generating plant -- like a coal, natural gas or nuclear plant – if there is a problem with that system's turbine it is unable to produce any power. Loss of an entire centralized power plant is a more significant reliability issue for the Midwest Independent System Operator ("MISO") than the loss of a wind turbine whose output might be in the range of 0.8 to 2.0 megawatt-hours.

B. Improvements in Wind Integration into the Transmission System since 2008

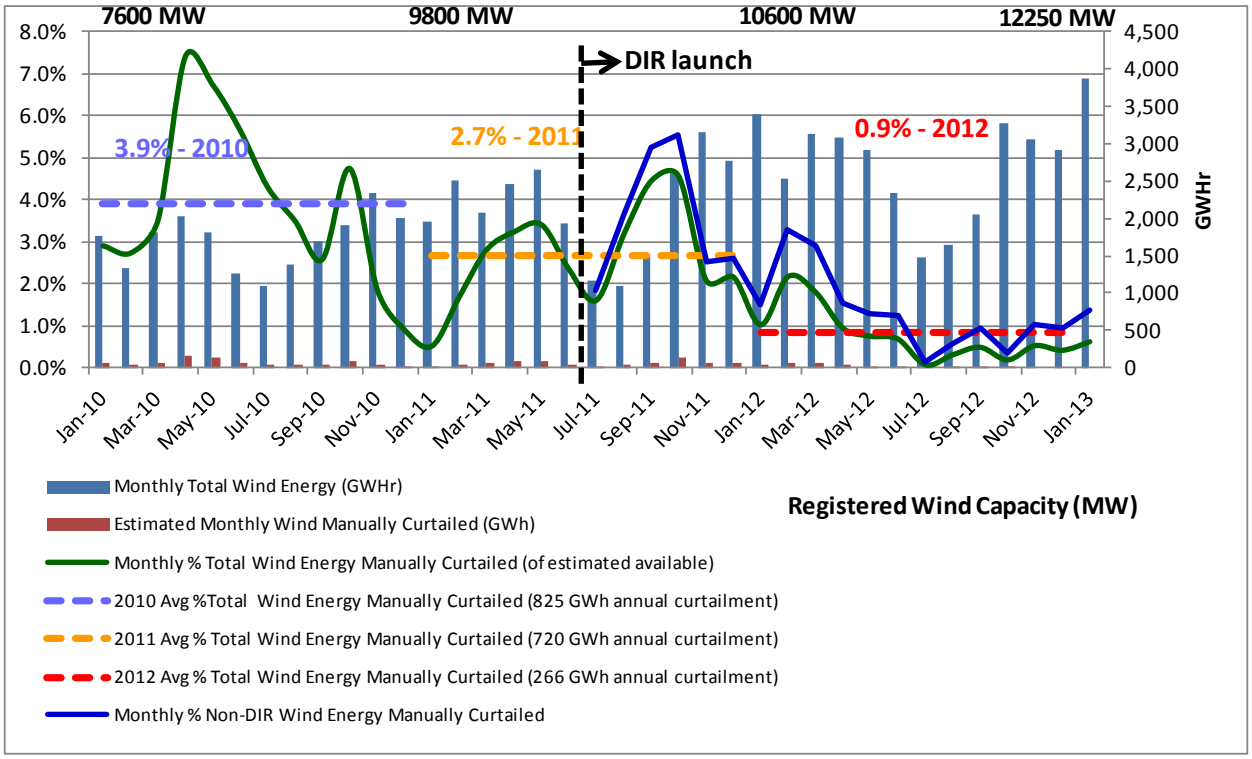
Since the Michigan RES was approved in 2008, MISO has established a few measures to improve the integration of wind into the electricity grid it manages. First, MISO requires wind facility operators to submit day-ahead forecasts. The forecasts become more accurate the closer in time they are to the actual time of generation. And as mentioned above, they are expected to increase in accuracy.

Second, MISO has implemented dispatchable intermittent resource technology ("DIR"). This allows MISO to remotely curtail or start up a windfarm to alleviate transmission line congestion or optimize usage of line capacity. Windfarms put in service after April 1, 2005 and that do not have contracts providing them firm transmission service must switch to DIR.

The measures put in place by MISO have worked well. Wind generation in MISO has increased ten-fold in five years. Installed wind generation in MISO is 12,270 MW (as of March 2013). MISO experienced its record wind peak in November 2012 when 10,012 MW of wind

power was being generated. That was approximately 25% of total generation output at the time and that was managed with no adverse consequences.

Since DIR was put in place, wind has increased from approximately 10,000 MW to 12,260 MWs. The graph below shows that prior to the implementation of DIR on average 3.9% of wind energy was being curtailed. After DIR was put in place the average amount of wind energy being curtailed dropped to 0.9%. It is noteworthy that the drop in curtailed wind energy occurred at the same time that the amount of wind generating capacity was increasing from 10,000 to 12,270 MWs – a 20% increase. That seems to indicate that DIR is able to effectively manage the integration of large amounts of wind energy into the grid.



SOURCE: Midwest ISO, Feb 2013, presentation to Reliability Sub-committee & Monthly Informational Forum.

The use of DIR has enabled wind to compete on a level playing field with other types of generating resources. This is in contrast to other regions of the country, *e.g.* Bonneville Power Administration (in the Northwest), who have initiated integration charges for wind in lieu of developing market-based solutions or changing operational protocols to more cost-effectively integrate wind into the system. Additionally, uneconomic wind curtailment has basically disappeared since the implementation of DIR, which has a positive impact on wind plant operations.

5. OTHER BENEFITS: What other benefits does wind energy provide?

A. Payments into local areas of Michigan

Payments to Landowners

Nearly all wind projects are built on private land leased from the landowner. Typically, a landowner signs a contract granting the developer the right to use his/her land and the air rights above it for wind development. In exchange for those rights the developer pays either royalties or lease payments to the landowner. While we don't have Michigan specific data, the American Wind Energy Association estimates that annual income from a single 1.5 megawatt wind turbine in the United States can range up to $6,000 per year. Landowners in Michigan, once the 10% requirement is met in 2015, would annually receive approximately $15,630,000. That means a landowner could receive approximately $120,000 per turbine for over twenty years.[10]

In addition to providing a steady revenue stream to landowners, it appears that windfarms have helped prevent property values from dropping in Michigan. A recent article on property value rankings listed the change in property value from 2011 to 2012. Four of the top six counties with the best total value change have windfarms – Gratiot (#1 in total value change from '11/'12), Sanilac (#2), Huron (#3) and Delta (#6). All four counties experienced a positive growth in property value, and only eight counties in Michigan had a positive total value change.[11]

Personal Property Taxes

Property tax rates vary from state to state and across a state. While we do not have exact data for Michigan, we can provide a sense of scale of the amount of payments typically made by windfarms. Property tax payments could be in the range of $15,000 to $20,000 per megawatt. If we assume that 3,900 megawatts of wind generation capacity is needed to meet the 10% requirement, Michigan could receive property taxes somewhere in the range of $58.5 to $78 million on an annual basis.

Wind farms have large footprints that typically touch more than one township. Therefore, numerous townships could benefit from these payments.

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[10] AWEA, Rural Development Fact Sheet, *available at* http://www.awea.org/learnabout/publications/factsheets/upload/Rural-Development_AWEAFactsheet_11-2011.pdf

[11] The Center for Michigan, Bridge Magazine, *Who's No. 1? County-by-county rankings on property values in Michigan* (April 4, 2013), *available at* blog.mlive.com/business_impact/print.html?entry=/2013/04/whos_no_1_county_ran.html

White and Benton Counties in Indiana are home to approximately 1,339 megawatts of wind generating capacity built since 2009. Property tax payments from those windfarms have helped these counties balance their budget and put money into schools without adding further stress to residential property taxes.[12]

CONCLUSION

Wind on the Wires appreciates the Governor Snyder, Chariman Quackenbush, Director Bakkal and the staff of the Public Service Commission and Michigan Energy Office looking into these issues. Based on the facts presented above we believe there is sufficient resources, from wind alone, to warrant a sizable increase in the renewable energy standard ("RES") in Michigan. Michigan has access to sufficient resources, and there is a need to diversify the energy portfolio used by Michigan electric consumers to hedge against potential fossil fuel volatility.

Wind energy prices from 2011-2012 (inclusive of the production tax credit) will likely drop in the near term due to advances in turbine technology, wind forecasting and the use of dispatchable intermittent resource technology. Wind energy reliability is improving and will continue to be reliable due to the advances in turbine technology, in wind forecasting and in the use of dispatchable intermittent resource technology.

Another factor that should be considered when increasing the RES is the locally distributed benefits wind energy provides. Wind energy provides local benefits across Michigan in the form of royalty payments to landowners, and property tax payments to Townships who can then use that money to pay down debt, and pay for local schools and roads.

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[12] Testimony of Benton County Economic Development Coordinator, Kelly Kepner and White County Economic Development Coordinator, Connie Neininger at Indiana Regulatory Flexibility Committee hearing held on 9/6/2012.

Email: czumskifinke@windonthewires.org

APPENDIX: Responses to Common Wind Issues Raised During the Public Hearings

Below are responses to wind-related issues raised by persons attending the public hearings. The heading responds to the issue and is followed by a short discussion of supporting facts. Each section concludes with links to reports, studies or articles that support the proposition.

1. Utility-scale windfarms have improved community property values

   - Several studies have been conducted on the impacts of large-scale windfarms on property values. The studies found no negative pricing impacts on home or property values. More broadly, community impacts have been conducted and found the presence of wind to have positive results from increased tax revenues, jobs and local amenities resulting from the investment and development. This is evident in Michigan. A recent article in Bridge Magazine reviewed the change in county total property values from 2011 to 2012. Four of the top six counties whose property values have increased are home to windfarms. Only eight counties experienced an increase in property values over that time period.
     http://www.quora.com/Wind-Energy/Do-wind-turbines-reduce-the-value-of-nearby-properties/answer/Mike-Barnard
     http://eetd.lbl.gov/ea/ems/reports/lbnl-2829e.pdf
     http://www.awea.org/blog/index.cfm?customel_dataPageID_1699=16858
     blog.mlive.com/business_impact/print.html?entry=/2013/04/whos_no_1_county_ran.html

2. Renewable Energy Standards in Michigan and Across the Midwest have had no significant impact on electric rates

   - Renewable energy standards have been shown to have no significant impact on electric rates, and this is reflected in the experience of Michigan customers, in which thirty-six Michigan electric providers have no surcharge and the remaining twenty-three providers are under the cost cap. (MI PSC, RES Annual Report for 2013, figure 1 (2/15/2013)). Investment made in Michigan by the wind industry, has fostered a significant manufacturing presence in Michigan. The wind industry is bringing jobs to Michigan, not driving them away.
   - Renewable Energy Standards in the Midwest have shown little cost impacts. MN and IL have both looked at the compliance costs for their renewable portfolio standards. In MN, 11 out of 13 electric utilities self-reported that compliance with the RES had little or no significant impact on electric rates. The state's largest utility, Xcel Energy, which serves 50% of MN's load, reported that "energy prices were 0.7% lower with wind" on the system than without.

- The Illinois Power Agency ("IPA") reported that the addition of renewable energy to the state's electric system saved consumers upwards of $100 million in 2011, and its most recent report noted that it assumes the price impacts in 2012 to be similar to those experienced in 2011 (IPA, *2013 Annual Report* at 30 (March 2013)). The IPA found that wind and other renewables drove down wholesale electric prices, benefiting customers as well as businesses. These results are not unique to the Midwest. The Center for American Progress studied the impacts of renewable requirements on costs and found that there is no evidence that such requirements are causing electric costs to increase.

  http://www.awea.org/learnabout/publications/factsheets/upload/3Q-12-Michigan.pdf

  Illinois Power Agency, Annual Report: The Costs and Benefits of Renewables Resource Procurement in Illinois Under the Illinois Power Agency and Illinois Public Utilities Acts, (March 2012)

  Richard W. Caperton, *Renewable Energy Standards Deliver Affordable, Clean Power* (April 11, 2012): http://www.americanprogress.org/issues/green/report/2012/04/11/11397/renewable-energy-standards-deliver-affordable-clean-power/)

  "Years later, Wisconsin wind farm fears fail to materialize"; http://www.midwestenergynews.com/2011/12/20/wisconsin-wind-farm-fears-fail-to-materialize/

3. Wind energy is cost-competitive, and at times, cheaper, than coal generation.

- Only fully depreciated coal plants are cheaper than wind energy. Comparisons of the levelized costs of wind energy consistently show it as the lowest cost new generating source available.
- We suggest that the PSC and MOE consider recent studies on levelized cost of energy, such as: *Sustainable Energy in America 2013 Factbook*,by Bloomberg, and *Levelized Cost of Energy Analysis – version 6.0*, by Lazard. The U.S. Energy Information Administration also presents levelized costs of energy for 2018, however, their costs seem to be high with respect to onshore wind and low with respect to natural gas.

  Bloomberg Finance LP and the Business Council for Sustainable Energy, *Sustainable Energy in America 2013 Factbook*, at 14 (January 2013) , *available at* http://www.bcse.org/sustainableenergyfactbook.html;

  Lazard, *Levelized Cost of Energy Analysis – version 6.0*, (June 2012), *available at* https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2012/20121221/20121221%20PAC%20Supplemental%20Levelized%20Cost%20of%20Energy%20Analysis.pdf;

  United States Energy Information Administration (Annual Energy Outlook 2013).

4. Emerging technologies receive subsidies, and renewable energy sources -- like the oil, gas and nuclear industries -- have benefited from them.

   - Historically, in comparison to coal and gas, renewable energy sources have received very minor amounts of government support. In addition, subsidies to coal, oil and gas have become permanent fixtures in the tax code, while the wind industry has volunteered to transition off of subsidy support. As this happens, wind energy remains a very competitive generation source.

     http://www.dblinvestors.com/documents/What-Would-Jefferson-Do-Final-Version.pdf

     http://ecopolitology.org/files/2010/03/federal_energy_subsidies-600x580.jpg

     http://savannah.gatech.edu/infinitenergy/government.html

     "Should the government subsidize alternative energy?"; http://qn.som.yale.edu/content/should-government-subsidize-alternative-energy

5. Wind developers support local control over siting, as long as the township does not impose ordinances -- under the guise of implementing standards that reflect safety and public welfare – that are so onerous that they prohibit development.

6. Adding renewable energy to the transmission system increases energy diversity and additional transmission lines help reduce congestion on the transmission grid. MISO estimates that both yield cost savings for ratepayers.

   - Upgrades to our transmission system are coming due, to replace aging infrastructure but primarily in an effort to lower the overall production cost of electricity for ratepayers. MISO found that by increasing energy diversity within the footprint and improving generator availability by minimizing or eliminating transmission congestion, ratepayers save in the range of $1.2 billion and $1.5 billion over fifteen years. (See MISO Value Proposition) Adding renewable energy to the system increases energy diversity and additional transmission lines help reduce congestion on the transmission grid.

     https://www.midwestiso.org/WhatWeDo/ValueProposition/Pages/ValueProposition.aspx

     "Building Wind Energy Can Save Midwestern Consumers $00 Per Year"; http://thinkprogress.org/climate/2012/05/22/488495/building-wind-energy-can-save-midwestern-consumers-200-per-year/

     "Is wind power reaching a tipping point?"; http://www.midwestenergynews.com/2013/02/04/is-wind-power-reaching-a-tipping-point/

7. MISO and PJM can flexibly integrate wind energy into the generation mix with fossil fuels and nuclear.

   - As generation and grid management becomes centralized under a regional transmission operator, wind energy is integrated into the overall mix of generation resources so that the electricity demand in and among RTOs can be adequately met at all times. The use of Dispatchable Intermittent Resources allows MISO to control transmission system congestion related to wind energy by allowing MISO to remotely curtail a plant's output.
   - In November 2012 MISO experienced its peak wind day, in which wind provided approximately 25% of the energy. MISO was able to integrate that wind with little to no problems.
     "In Iowa, another view on how to solve wind's variability"; http://www.midwestenergynews.com/2013/03/26/in-iowa-another-view-on-how-to-solve-winds-variability/

8. The regional transmission organization maintains the same "stand-by" generation for wind energy sources as it does for the rest of its generating sources.

   - MISO manages large amounts of "back-up" generating capacity at all times should any generation source, including coal or nuclear, cease generating. The need and capability to smoothly transition from one resource to another is not unique to wind energy.
   - Wind speed changes relatively slowly and is predictable. Windfarm owners/operators use models/programs to predict wind speed. Industry experts expect the models to continue to improve as more data becomes available and programs become more sophisticated.
   - Wind speed changes more slowly than changes in electricity supply, demand or a plant outage. Therefore, it is no more unreliable than the current operation of the grid that the transmission system operator has to currently manage.
     "Q&A: Can renewables alone (with storage) power the grid?; http://www.midwestenergynews.com/2013/01/11/qa-can-renewables-alone-witih-storage-power-the-grid/

9. Wind does contribute to peak load. For 2013, the wind energy capacity value at peak is forecasted to be 13.3%, which is up from 8% in 2012.

10. Windfarms bring construction jobs, manufacturing jobs and provide widespread payments in the local economy in the form of land leases and taxes

    - A 250MW wind farm creates 1,100 jobs and brings millions of dollars to local communities. Though some of these jobs are temporary construction, additional

jobs are always created. Non-construction jobs account for 577 of these jobs, in manufacturing, planning and development, sales, operations and maintenance.

- The American Wind Energy Association estimates that annual income from a single 1.5 megawatt wind turbine in the United States can range up to $6,000 per year. Landowners in Michigan, once the 10% requirement is met in 2015, would annually receive approximately $15,630,000. That means a landowner could receive approximately $120,000 per turbine for over twenty years.
- While we do not have exact data for Michigan, we can provide a sense of scale of the amount of payments typically made by windfarms. Property tax payments could be in the range of $15,000 to $20,000 per megawatt.

  http://www.nrdc.org/media/2012/120911.asp
  http://www.awea.org/learnabout/publications/factsheets/upload/Rural-Development_AWEAFactsheet_11-2011.pdf
  http://www.bls.gov/green/wind_energy/

11. Studies continually show there is no relationship between the noise produced by wind turbines and negative health impacts.

- Seventeen studies from around the globe, including national health departments, private and university studies demonstrate that no negative health impacts can be linked to wind turbines.

  http://cleantechnica.com/2012/12/27/wind-turbine-syndrome-not/
  "Can Wind Turbines Make you Sick"; http://www.slate.com/articles/health_and_science/alternative_energy/2013/03/wind_turbine_syndrome_debunking_a_disease_that_may_be_a_nocebo_effect.html
  "Science proves wind energy is safe"; http://www.jsonline.com/news/opinion/science-proves-wind-energy-is-safe-0c8aejk-186395431.html

12. Wind turbine sound levels are comparable to driving in a vehicle or working in an office

- Wind turbines are much quieter than many day to day activities that one encounters. At a distance of 350 meters, closer than nearly all turbines are currently sited, turbines produce lower level noise than one experiences while driving a vehicle, in the standard office space, or even noise in a common household.

  http://www.awea.org/learnabout/publications/upload/Utility-Scale-Wind-Sound-Fact-Sheet_WP11.pdf
  "Federal Guidelines a Step Forward for Bird-Friendly Wind Development"; http://www.audubon.org/newsroom/press-releases/2012/federal-guidelines-step-forward-bird-friendly-wind-development

"Wind Farms: A Noisy Neighbor?; http://www.renewableenergyworld.com/rea/news/article/2013/02/wind-farms-a-noisy-neighbor

"The Nocebo Effect: Wind Farm Health Worries Probably Caused By Anti-Wind Scare Campaigns"; http://thinkprogress.org/climate/2013/03/15/1725401/the-nocebo-effect-wind-farm-health-worries-probably-caused-by-anti-wind-scare-campaigns/

13. The threat to birds from wind turbines is insubstantial

- For every 10,000 bird deaths that result from human development and pets, less than 1 results from wind turbines. The threat to birds posed by fossil fuel use and climate change, according to the World Wildlife Fund, "equals the sum of all other human-caused threats combined", and the president and CEO of the National Audobon Society has said that renewable energy is a solution for birds, and "wind energy is a key player in that mix."

  http://masscec.com/masscec/file/Wind_Guide(1).pdf

  http://www.wwfblogs.org/climate/sites/default/files/WWFBinaryitem7659.pdf

  http://www.fws.gov/cno/press/release.cfm?rid=373

  "Letter: Wind turbines kill fewer birds"; http://elkodaily.com/news/opinion/letter-wind-turbines-kill-fewer-birds/article_cbb317d4-95b1-11e2-8aa6-001a4bcf887a.html

  "Are Wind Turbines Getting More Bird and Bat Friendly?"; http://www.scientificamerican.com/article.cfm?id=wind-turbines-and-bird-conflicts

14. New technology and siting standards are reducing impacts of wind turbines on bats

- The wind industry is addressing the issue of bat mortality head-on so as to minimize impacts on bats. New technology and siting standards are reducing the impact of wind energy on bats and wildlife. Just as new blade technology and siting policies have brought avian mortality to extremely low levels, the same progress is being made on bats.

  http://www.awea.org/learnabout/publications/upload/Wind-Energy-and-Wildlife_May-2011.pdf

  "Are Wind Turbines Getting More Bird and Bat Friendly?"; http://www.scientificamerican.com/article.cfm?id=wind-turbines-and-bird-conflicts

15. Recent reductions in the overall amount of CO2 and major pollutants is not a reason to stop focusing on the use of wind energy resources

- CO2 is decreasing, largely as the US reduces its reliance on coal. This transition to a lower carbon and greenhouse gas polluting energy sources represents a move in the right direction, and continued efforts to transition away from fossil fuels is positive.
- Increasing the percentage of renewable energy capacity in the generation portfolio of Michigan electric providers will increase its diversity. Diversity acts as a price hedge against fossil-fuel price volatility.
- Increasing the amount of wind energy sources within Michigan will continue to inspire the growing manufacturing base within Michigan, will bring new tax dollars and land lease payments from windfarms into a large area that will cover multiple townships. Those payments have been used by some townships and counties to pay off debt, cover increasing costs of schools and keep residential property taxes low.

  http://www.eia.gov/todayinenergy/detail.cfm?id=10691

  "Environmental Impacts of Wind Power"; http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-wind-power.html

16. Production of turbine parts causes no more pollution than making parts for other generators. However, a life-cycle analysis of coal-fired generation components reveals they produce twenty times more greenhouse gas emissions per kWh produced than wind or solar

    - A life cycle analysis of renewable energy shows that greenhouse gas emissions are significantly lower than those of traditional fossil fuel sources. In a cradle-to-grave analysis, the National Renewable Energy Lab found that coal-fired generation produces 20 times more greenhouse gas emissions per kWh than wind or solar.

      http://www.nrel.gov/analysis/sustain_lca_method.html

17. Contracts with private individuals for land and air rights are entered into freely and are part of a bargained-for exchange. Many wind companies will provide stipends to landowners so they can have contracts reviewed by counsel.

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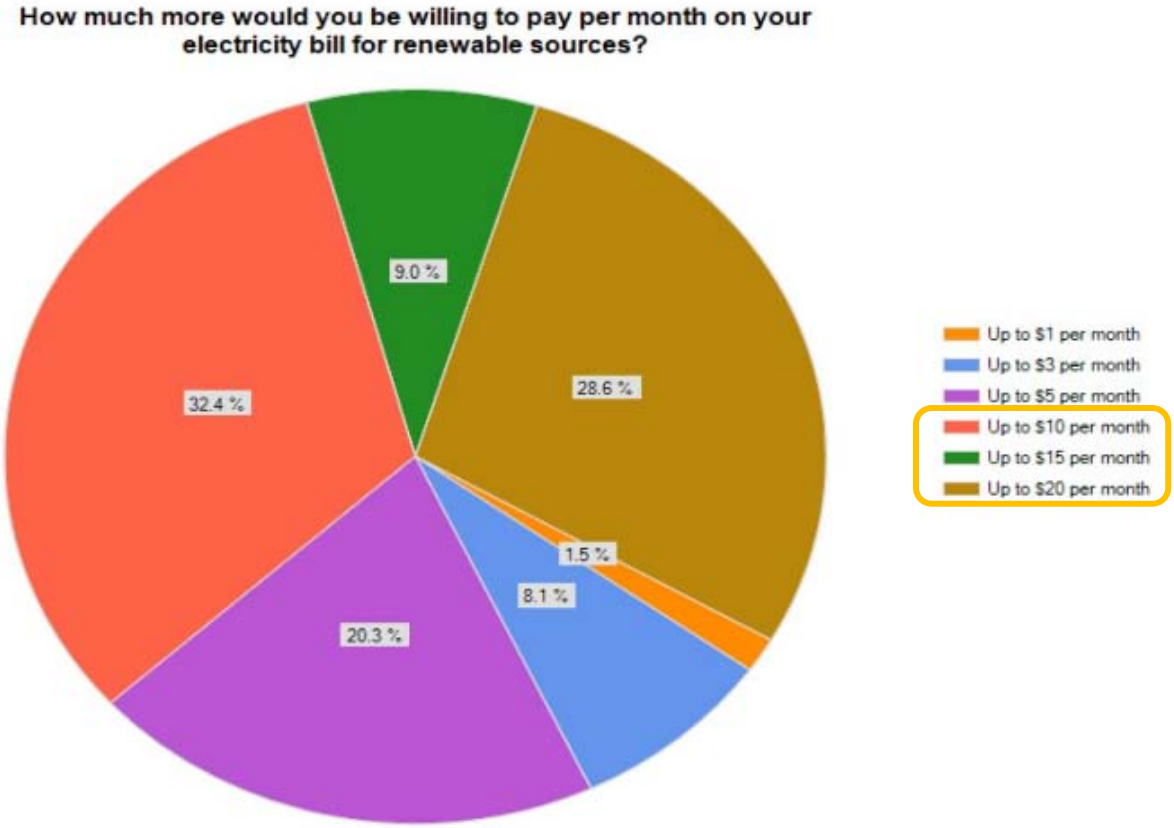
18. Many people in Michigan are willing to pay up to $10 additional per month to sponsor an energy portfolio that causes less environmental harm

- A survey conducted by member organizations of the Grand Vision Energy Network and members of the Northwest Michigan Council of Governments shows that about 70% of people in Northern Michigan counties would be willing to pay more than $10 per month to receive renewable energy resources.



SOURCE: Hans Voss, *Welcome to Traverse City* presentation, slide 4, citing a random non-scientific, online and paper survey of 2,179 residents in six northwestern Lower Michigan counties that was conducted by member organizations of the Grand Vision Energy Network and members of the Northwest Michigan Council of Governments, coordinated and summarized by the NorthSy Nonprofit Network, a service organization based in Traverse City.

Electricity Restructuring in Michigan:
The Effects to Date of Public Act 141 and Potential Future Challenges

2006

Prepared for

Michigan Municipal Electric Association
and
Protect Michigan

Prepared by

Public Sector Consultants Inc.
www.pscinc.com

Overview

With the passage of Public Acts (PAs) 141 and 142 of 2000, the Michigan Legislature ushered in a new era for customers purchasing retail electric supply. Previously, electricity providers in Michigan operated under a natural monopoly market structure whereby utilities—regardless of whether the utility was investor owned, a co-operative, or a municipal corporation—were provided a near-exclusive geographical area of service in return for regulated rates and an obligation to serve all customers in the area. Natural monopolies were believed to be the most effective means of providing reliable and economic service because electricity production is a capital-intensive industry whose elements (generation plants, transmission lines, and local distribution systems) are expensive and durable. Having overlapping development of these costly systems in a given area is inefficient, and the public policy response was therefore to officially "recognize" the monopoly status of local energy providers and highly regulate their rates as a substitute for competition and to constrain monopoly pricing power. The utilities also were required to accept an obligation to supply, transmit, and deliver the commodity to all retail customers, which was sold to the customer in the form of a bundled electric product.

Beginning in the 1990s, however, the monopoly status of power companies to produce electricity was challenged. States with high electricity costs, including Michigan, believed that ending the monopoly status for the supply or generation of electricity would lead to lower prices and more efficient operation of incumbent utility companies. This was an intended purpose of PA 141, which restructured Michigan's electric industry by

- allowing customers to purchase their generation needs from an alternative energy supplier (AES) at a market rate,
- requiring regulated utilities to divest their transmission facilities or join a multistate regional transmission system organization approved by the Federal Energy Regulatory Commission (FERC),
- creating limits on the market share for generation capacity in Michigan's energy market, and
- lowering residential rates by 5 percent while simultaneously freezing any future increases until January 1, 2006.[1]

PA 141 has been in effect for over six years. Since the cap on residential rates has now expired, it is an appropriate time to take a look back at the successes and failures of electric restructuring in Michigan and review the lessons learned. This report will examine the history of PA 141—and its implementation by the Michigan Public Service Commission—and analyze the emerging and significant challenges Michigan's electric choice market will face over the next decade.

[1] Suzanne Lowe, "Electric Industry Restructuring in Michigan," Senate Fiscal Agency, July/August 2000.

Electricity in Michigan Before Public Act 141

Prior to PA 141, the majority of electricity in Michigan was provided by two main companies: Consumers Energy (Consumers) and Detroit Edison (Edison). Together, these two companies supplied approximately 90 percent of the power in the state.[2] Their product offerings (tariffs) were regulated by the Michigan Public Service Commission (MPSC), which established rates for customers that included an allowed rate of return on investment for the power companies.

In return for their monopoly status, incumbent utilities accepted an obligation to serve all customers who requested service and were willing to pay the regulated rates. In practice, this meant that incumbent utilities were required to possess the necessary generating capacity or purchase electricity from other utilities to serve all retail customers within their assigned service territories. As will be discussed below, it is not clear how or if this obligation to serve has been changed by the implementation of PA 141. The uncertainty regarding the scope of a utility's obligation to serve under PA 141 is a primary failure of the law's implementation and is a significant stumbling block to the creation of an actual market for electricity in the state.

PA 141 altered this long-standing regulatory framework by allowing alternative electric suppliers (AESs) to sell energy to willing retail customers using incumbent utility distribution lines and the transmission lines of the newly formed, independent transmission companies. Unlike most other states that restructured at the time, in Michigan electric generation facilities owned by incumbent utilities remained regulated. In particular, regulated utilities retained an obligation to serve (at a regulated rate) any customer that

- chose to remain with the incumbent utility or returned to the incumbent from an AES, or
- left the incumbent utility and now purchases electricity directly from an AES.

The regulated rate structure in place before the implementation of PA 141 was both "bundled" and "skewed." A bundled rate combines all of the various charges associated with electric service (generation, transmission, and distribution) into a single rate or charge. Skewing refers to the fact that regulated rates for rate classes (residential, commercial, and industrial) are not set at actual cost; rather, some rates are intentionally set above cost (in Michigan, commercial and industrial rates) to allow others to be set below cost (residential rates). According to the MPSC, "Current full-service rates reflect the commission's long-standing policy of having commercial and industrial (C&I) customers provide residential customers with an interclass subsidy."[3] Specifically, regulated residential rates were set at approximately 10 to 20 percent below the actual cost of providing service, while commercial rates for regulated utilities were set at 10 to 20 percent above the cost of service. These skewed rates were *not changed* by PA 141, or by subsequent MPSC rulings, and therefore continue to distort the market since regulated prices offered to customers do not reflect the actual costs of electric service.

[2] Mark Hornbeck and Charlie Cain, "Energy Choices Falter in Michigan," *The Detroit News*, June 5, 2005.
[3] Michigan Public Service Commission, Case No. U-14399, p. 32.

Industrial rates more closely approximated the actual cost to serve in part because large industrial customers have historically been in a better position to influence their rates in the rate setting process. This is accomplished through a variety of means including, but not limited to, negotiation with the utilities (resulting in the past in special contracts or today in new low rate tariffs approved by the MPSC), "litigating" through the administrative ratemaking process, and using the considerable political capital possessed by large employers in the state.

Challenges Presented by Electric Restructuring

Ending the monopoly supply of electricity presents difficulties for policymakers. One challenge is the issue of stranded costs—those costs incurred by regulated entities prior to competition to meet their obligation to serve which become "stranded" or unrecovered due to customers leaving the utility for an AES. As customers shift to AESs, regulated utilities find themselves potentially unable to recoup the cost of business decisions made prior to the switch. Recovery of the costs of these business decisions (such as power plant construction) was permitted by the regulators during the monopoly period after a standardized review. Michigan PA 142 attempted to address part of the stranded-cost issue by allowing Consumers and Edison to securitize, or refinance, certain stranded costs in bonds worth $2.2 billion. PA 141 required these bonds to be paid off through a *non-bypassable* surcharge paid by customers of both incumbent utilities and AESs. As will be discussed later, subsequent decisions by the MPSC allowed this charge to be effectively bypassed by choice customers thus creating an "artificial incentive"[4] for leaving a regulated utility.

In addition to stranded costs, the introduction of customer choice creates the incentive for the "cherry picking" of larger, higher-margin credit-worthy customers by new entrants. In Michigan, these customers are the midsized and larger commercial and industrial clients paying regulated rates that were higher than the actual cost to serve them—a function of Michigan's skewed rates for these rate classes—and not individual residential customers. This issue of new entrants targeting higher-margin customers paying skewed rates was exacerbated by a series of subsidies and credits created by the MPSC early in the implementation of PA 141 that artificially increased the attractiveness of entering the choice program.

Another challenge is defining the regulated utility's ongoing service obligations, including long-term supply reserve obligations, in a regulatory framework where customers are free to choose an alternative supplier and alternative suppliers are allowed to choose which customers they wish to do business with. The traditional regulatory framework is one where utilities accept an obligation to provide electricity to all potential customers, usually in a given geographic service area. This obligation to serve a defined set of customers is one factor used by utilities to determine the necessary supply and reserve production capacity to maintain reliable service—which in turn determines future investments in equipment by utilities.

Today, AESs, which have no obligation to serve, enter into fixed-term contracts with customers of their choosing and are allowed to decline to serve customers seeking energy if it is not in their business interests. This grants an AES a great deal of freedom to accept only high-margin, credit-worthy customers and to develop generating capacity or

[4] PSC is using the term "artificial incentives" because while the incentives were quite real to customers—as actual savings through payments and/or credits against balances due to utilities—they were not created through natural market forces, but rather through the nonmarket (artificial) actions of government policies.

purchase electric supply to match actual, not potential, demand. When a customer chooses to leave an AES, regulated utilities must accept them back under return to service rules established by the MPSC. In other words, regulated utilities are required to either maintain excess generating capacity for customers that may or may not return—and spread the costs of this excess generating capacity across their remaining customers—or to purchase electric power at market prices while giving the customer a rate based on the average costs of the entire utility. Either way, the regulated utility is required to operate in a higher-cost, less efficient manner, the higher cost of which is not passed on to the returning customer. This is a fundamental disconnect between price and purchasing decisions for the returning customer that disrupts the ability of the market to send signals through prices. In addition, this regulatory structure requires regulated utilities to be prepared to serve a customer base with an unknown number of actual customers on a year-to-year basis, which in turn makes decisions about future capital investments more difficult.

This current framework is not economically sustainable in the long run. Requiring only regulated utilities to maintain excess capacity or sell the excess capacity only to buy at a higher market rate upon the return of a customer creates an uneven playing field in favor of AESs. The PA 141 regulatory model provides participating customers the benefit of choosing between the lower of market prices or regulated full service rates. When competitive market prices are low customers can leave their incumbent utility and purchase power directly from an AES, but when competitive market prices are high incumbent utilities are **required** to take them back as part of their obligation to serve. It is a question of public policy for Michigan as to how to deal with this. Implementing tenets of economic theory gives the state with a number of choices along a policy spectrum. At one extreme, the state can move toward a truly competitive market—where no company has an obligation to serve and economic theory holds that reliability will likely decrease along with price. At the other end of the policy spectrum, Michigan can return to a fully regulated framework with no consumer choice, and, again according to economic theory, increased reliability. Between these two extremes are a range of hybrid choices to restructure the market—as PA 141 attempted to do—with a mix of competitive and regulated models.

It is beyond the scope of this project to state which of these paths is correct or how precisely the price of electricity or reliability of the electric supply may ultimately be affected. What is clear, however, is that the current partially deregulated status of PA 141 is not sustainable, does have an impact on reliability, and causes regulated utilities to operate in a less than efficient manner.

Initial Effects of PA 141

Due to the different treatment of classes of customers under PA 141 and continuing MSPC rulings, the law's effects have been dramatically different between business and residential customers. Evaluating PA 141's effect on customers is thus best accomplished by examining the law's effect on each of these different rate classes. In addition, PA 141 can be evaluated based on the size and depth of choice offerings available to customers.

RESIDENTIAL CUSTOMERS

As was previously discussed, regulated rates in Michigan have historically been skewed in favor of residential customers. This long-standing regulatory framework was not changed by PA 141 or by subsequent MPSC rate cases. In addition to this subsidy, PA 141 enacted an immediate 5 percent rate reduction for residential customers that remained in effect until December 31, 2005.

This price reduction and multi-year rate cap has been extremely beneficial to residential customers in Michigan, as nationwide inflation in energy costs over this period has exceeded 20 percent and the consumer price index during the same period has increased 9.7 percent.[5] On the other hand, this six-year freeze and cap on regulated rates is a primary reason for the lack of the development of a choice market for residential customers, a situation made worse with rate skewing. Quite simply, the regulated rates being charged these customers were too low to attract AESs. This together with credit worthiness and load type has resulted in almost no residential customers participating in the choice program and no AESs actively marketing to the residential customer base. This was to be expected. Richard Mattoon of the Chicago Federal Reserve said, "If the price is set artificially low, new entrants to this competitive market will not appear, since the margin will not be sufficient for them to capture customers. This will undermine the development of a competitive market."[6]

December 31, 2005, marked the end of the rate cap on regulated residential electricity rates. For the first time since the passage of PA 141, residential customers in Michigan experienced increased electricity rates:

- In 2004, the MPSC granted Edison an increase of $335.8 million.[7] Edison had requested base rate increases of $582.8 million, most of which was related to the effects of PA 141 and the costs of required investments related to environmental issues. The MPSC order granted the rate increase, spread evenly across all rate classes, but delayed the increase in residential rates until after the rate cap expired on January 1, 2006—when residential rates increased 12.5 percent.
- In 2005, the MPSC granted Consumers a rate increase of $86 million[8]—71 percent less than the $320 million initially requested by the company.[9] In this order the

[5] Public Sector Consultants calculations used Bureau of Labor Statistics CPI data.
[6] Richard Mattoon, "The electricity system at the crossroads—policy choices and pitfalls," *Economic Perspectives*, Chicago Federal Reserve, 1Q, 2002.
[7] Case U-13808.
[8] Case U-14347.

MPSC also declined to begin the process of de-skewing rates as requested by Consumers. In a separate case,[10] the MPSC approved the recovery of $333.4 million of deferred investment costs over a five year period for Consumers; deferral of these costs was required by PA 141. The rate increases from both of these Consumers cases for residential customers were delayed until January 1, 2006, when the effect for customers was a combined 9.8 percent increase in residential rates.

BUSINESS CUSTOMERS

Unlike residential customers, business customers have taken advantage of choice in much larger numbers. During 2005, about 15,000 of the 3.7 million customers of Edison and Consumers participated in the choice program, representing about 12 percent of energy sales in the Edison and Consumers territories.[11] Essentially all the participants in these programs are in either the commercial or industrial class. In the Consumers' service area, the mix of choice participants is roughly 35 percent commercial and 65 percent industrial. This mix is nearly the opposite in Edison's service area, with approximately 25 percent of choice sales to industrial clients and 75 percent to commercial clients.[12]

As previously discussed, commercial customers in Michigan have traditionally paid regulated rates that are measurably above the actual cost to serve them.[13] As a result of both the size of contracts and skewed rates, customers in these classes became an immediate target of AESs with the passage of PA 141. Allowing commercial clients to escape the forced subsidization of residential customers has been one significant benefit of PA 141 to commercial customers. The problem, however, is that a series of MPSC decisions have allowed commercial and industrial customers in the choice program to enjoy even greater "savings" than simply those created by skewed rates. Specifically, choice customers were allowed (for a period of time) to enjoy freedom from the supposedly non-bypassable surcharge created by securitization and refinancing under PA 142, and choice customers also received a credit equivalent to the regulated customer's rate cap savings.

DEVELOPMENT OF CHOICE MARKET

One goal of PA 141 was the development of a vibrant market for electricity generation in the state. As has been stated above, very few residential customers in Michigan currently receive service from AESs, even though a number of AESs have been licensed by the MPSC to offer service. Instead, most AESs serve only business customers in the state. Exhibit 1 details the number and size of AESs operating in Consumers' territory. Exhibit 2 offers the same information for Edison's territory.

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[9] *Megawatt Daily*, "Michigan PSC Slices Consumers' Rate Request," December 23, 2005.
[10] Case U-14148.
[11] Michigan Public Service Commission, "Status of Electric Competition in Michigan," February 1, 2006, p. 2.
[12] *Ibid.*, pp. 3–4.
[13] Small commercial customer rates were capped until December 31, 2004, and all other customers received a rate freeze until December 31, 2003.

EXHIBIT 1
Number and Size of AESs Operating in Consumers' Territory

AES Name[1]	Number of Customers 2001	2002	2003	2004	2005	Megawatts Served 2001	2002	2003	2004	2005
CMS M&T	0	0	2	2	2	0	0	2	2	2
Constellation	0	0	183	477	671	0	0	61	229	151
MidAmerican					4					1
Mirant[2]	0	0	4	0	0	0	0	22	0	0
Nordic[3]	0	4	18	16	12	0	25	35	33	8
Quest	327	467	494	314	96	217	380	411	395	105
Sempra	0	0	9	55	43	0	0	13	47	49
Strategic	0	0	89	591	323	0	0	9	99	46
Wolverine Power	2	5	15	18	21	9	43	105	121	157
WPS	0	0	0	0	21	0	0	0	0	32
Total	**329**	**563**	**814**	**1,473**	**1,193**	**226**	**473**	**658**	**926**	**552**

SOURCE: Michigan Public Service Commission, "Status of Electric Competition in Michigan," February 1, 2006, attachment 1.

[1]Companies not actively serving customers since 2002 are not included in this table. Totals for 2002 include 87 customers and 25 MW served by companies that have since exited the Consumers Energy market. By 2003, those customers either switched to another AES or returned to full service from Consumers Energy.

[2]On July 14, 2003, Mirant America Retail Energy Marketing, LP, filed for Chapter 11 bankruptcy.

[3]The companies formerly known as Nordic Energy and Nordic Electric were restructured in 2004. Nordic operated in Michigan as both Nordic Marketing, LLC, and Nordic Marketing of Michigan, LLC, after that time. For purposes of this report, all Nordic Companies are combined in this one row.

EXHIBIT 2
Number and Size of AESs Operating in Detroit Edison's Territory

AES Name[1]	Number of Customers 2001	2002	2003	2004	2005	Megawatts Served 2001	2002	2003	2004	2005
CMS MST Michigan, LLC	11	11	11	11	11	261	261	261	261	261
Commerce[2]	0	953	3,420	4,663	3,070	0	35	181	215	104
Constellation	0	0	1,325	1,881		0	0	303	356	532
Cook Inlet	0	9	9	9		0	86	86	86	0
Dillon	0	0	149	136		0	0	33	28	<1
Dynergy	0	0	10	0		0	0	5	0	0
Energy International	0	73	773	1,231	613	0	5	36	55	28
Exelon	0	0	0	0	42	0	0	0	0	8
FirstEnergy Solutions	0	5	952	1,234	956	0	3	171	180	118
Metro Energy	0	2	2	2	2	0	13	13	13	13
MidAmerican	0	0	0	66	806	0	0	0	4	31
Mirant[2]	0	0	6	0	0	0	0	8	0	0
Nicor/EMC	246	1,012	66	10	0	18	169	4	1	0
Nordic[3]	1,159	1,312	1,718	1,838	10	77	107	162	140	<1

	Number of Customers					Megawatts Served				
AES Name[1]	**2001**	**2002**	**2003**	**2004**	**2005**	**2001**	**2002**	**2003**	**2004**	**2005**
Premier	0	0	327	632	207	0	0	53	77	19
Quest	620	1,287	1,477	1,262	774	141	325	422	347	104
Sempra	0	33	98	162	16	0	26	59	80	5
Strategic	0	0	2,000	4,095	3,068	0	0	245	475	237
Wolverine	0	2	2	2	2	0	13	13	13	13
WPS	0	0	4	7	503	0	0	15	45	49
Total	**2,036**	**5,198[1]**	**12,349**	**17,241**	**13,664**	**497**	**1,138[1]**	**2,070**	**2,378[4]**	**1,524**

SOURCE: Michigan Public Service Commission, "Status of Electric Competition in Michigan," February 1, 2006, attachment 4.

[1]Companies not actively serving customers since 2002 are not included in this table. Totals for 2002 include 87 customers and 25 MW served by companies that have since exited the Consumers Energy market. By 2003, those customers either switched to another AES or returned to full service from Consumers Energy.

[2]In 2005, Electric-American changed the company name to Commerce Energy Inc. On July 14, 2003, Mirant America Retail Energy Marketing, LP, filed for Chapter 11 bankruptcy.

[3]The companies formerly known as Nordic Energy and Nordic Electric were restructured in 2004. Nordic operated in Michigan as both Nordic Marketing, LLC, and Nordic Marketing of Michigan, LLC, after that time. For purposes of this report, all Nordic Companies are combined in this one row.

[4]Total does not add correctly due to rounding.

Many of the initial incentives attracting commercial customers to AESs were a result of MPSC-created credits and interclass subsidies. Figures from 2005 indicate that the size of the choice program has decreased throughout the year. From January to December 2005, there was a 40 percent decrease in the electricity provided by AESs in Consumers' territory and 20 percent decline in Edison's territory.[14] Portions of this decline were most likely caused by the cessation of some of these artificial incentives favoring AESs, fuel cost increases to the AESs passed along to choice customers as multi-year electricity contracts expired and were renewed, and federal regulatory decisions that have led to increased transmission costs that more greatly affect those AESs that rely on imported electricity to serve their customers.

[14] Michigan Public Service Commission, "Status of Electricity Competition in Michigan," February 1, 2006, pp. 3–4.

What Has PA 141 Taught Michigan About Price Signals?

Put plainly, PA 141 has taught Michigan that accurate, cost-based price signals do matter—particularly if legislation is intended to create an open and competitive market. In competitive markets, prices contain a vast amount of information, including some information about the quality and/or reliability of products. Customers use the information to make more informed purchasing decisions. If prices are artificially restrained, inflated, or subsidized, it is difficult for the market to operate efficiently.

ARTIFICIAL INCENTIVES CREATED BY THE IMPLEMENTATION OF PA 141

Economic theory underpinning the deregulation of natural monopolies suggests that savings to customers should be provided by the market, not by artificial government decisions. During the initial implementation of PA 141, however, many of the "savings" enjoyed by choice customers were created by the MPSC's handling of savings created through securitization. Pursuant to PA 142, Edison and Consumers securitized and refinanced certain costs and assets in order to minimize stranded costs. Both companies refinanced nuclear plant assets using debt financing with AAA-rated bonds.

Savings generated by these financing activities were used to provide the 5 percent residential rate reductions required by PA 141. However, the refinancing of Edison's assets provided sufficient savings to also reduce commercial and industrial rates by 5 percent and to fund a statewide Low Income and Energy Efficiency Fund up to $50 million per year (with approximately $20–30 million per year of residual savings).

The additional savings could have been used by the MPSC to either lower the rates for full-service customers of regulated utilities or to create savings for choice customers. In cases that implemented PA 141, the MPSC chose the latter and created artificial incentives for customers to enter the choice program. Specifically, it created two credits for these choice customers:

- A credit equivalent to the 5 percent rate reduction received by the customers of regulated utilities[15]
- A credit equal to the statutorily required non-bypassable securitization charge, which effectively allowed choice customers to waive a supposedly mandatory charge

In total, choice customers received greater benefits from refinancing than full-service customers, while bypassing the non-bypassable charge. In addition, distribution rates initially established by the MPSC under PA 141 for choice customers were not equal to the distribution rates charged to full-service customers. Through a combination of skewed regulated rates, nonequal distribution rates, rate reduction, and securitization credits, the

[15] This credit, since it was based on a 5 percent rate reduction for a higher priced service, resulted in even greater benefit to choice customers.

MPSC initially created a large artificial incentive for customers to take "advantage" of choice.

In a February 2004 decision, the MPSC removed some of the incentives for Edison customers to purchase electricity from an AES by ending the application of the two credits funded by the residual securitization savings and authorizing Edison to collect $44 million in stranded-cost charges allowed by PA 141. These changes, along with the increased market price of electricity, have eliminated some of the savings gained by switching to an AES, causing some choice customers to return to their former regulated utility. Even with skewed rates, the elimination of the credits and the increased price of electric generation meant that regulated rates were lower than the newer rates the AESs were charging.[16] It can be safely assumed that eliminating the skewed rates, and thus lowering the regulated rates paid by commercial customers, would entice more commercial customers to return to regulated utilities.

FROZEN AND SKEWED PRICES LIMITING COMPETITION

The subsidized and frozen prices have made it difficult for a truly competitive market to emerge for residential customers. Skewed regulated rates still remain in Michigan and continue to create an uneven playing field favoring AESs. The higher-than-cost regulated rates charged to commercial customers provide "artificial" headroom (the difference between the skewed rate and the incumbent's actual cost of production) for AESs to entice customers to participate in that choice program. For this reason, regulated utilities have requested that the MPSC de-skew the rate structure and phase out the long-standing cross-subsidization between business and residential customers.

In a December 22, 2005, rate case, the MPSC denied the regulated utilities initial attempt to phase out the residential subsidies present in the current regulated rates. In their decision, the MPSC said that "the Commission is not convinced that all customers should eventually pay rates that are based solely on the cost to serve them."[17] If policymakers are determined to establish a competitive market for electricity in the state, it is *critical* that prices are based on the cost to serve each class of customer. When regulated rates are not based on cost of service, regulators are creating artificial incentives for customers to enter the choice program. In the December 22, 2005, decision the MPSC openly stated that "C&I choice customers do not currently participate in paying the residential subsidy; nor do they pay their full distribution cost." When this is the case, it is impossible for regulated utilities to compete on a level playing field with AESs.

[16] Hornbeck and Cain, "Energy Choices Falter in Michigan."
[17] Michigan Public Service Commission, Case No. U-14399, p. 33.

Future Challenges to PA 141

DE-SKEWING

A critical development that will affect the success or failure of PA 141 to create a competitive electric market is de-skewing regulated rates. Until the market-based rates of AESs are competing with an incumbent utility's true costs to serve each rate class, AESs are competing against the upwardly skewed rates of an incumbent utility for commercial and industrial rate classes—which favors AESs—and against the downwardly skewed rates of incumbent utilities for the residential rate class—which favors the incumbents.

The process of de-skewing will dramatically change the landscape of electric choice in Michigan and will affect the competitiveness of the state's electric market. The most obvious results of de-skewing will be an increase in the rates charged to residential customers and a decrease in nonresidential rates, likely over a period of several years. This increase in the residential rate will do more than simply raise the electric bills of Michigan residents, it could also create the conditions necessary for AESs to market their services to residential customers for the first time. As regulated residential rates increase toward the actual cost to serve residential customers, there will be an increased incentive that attracts AESs to serve these customers.

De-skewing also will lower the rates charged to business customers, who will no longer be subsidizing residential customers. These lower rates will strip AESs of some of the noncost-related price advantage they currently possess, which will allow more fair competition to emerge. Ultimately, however, de-skewing alone will not lead to a truly free market as long as regulated utilities maintain an obligation to serve. This obligation will continue to act as an implicit tax on regulated utilities, increasing the cost of electricity generation for these companies.

UNBUNDLING

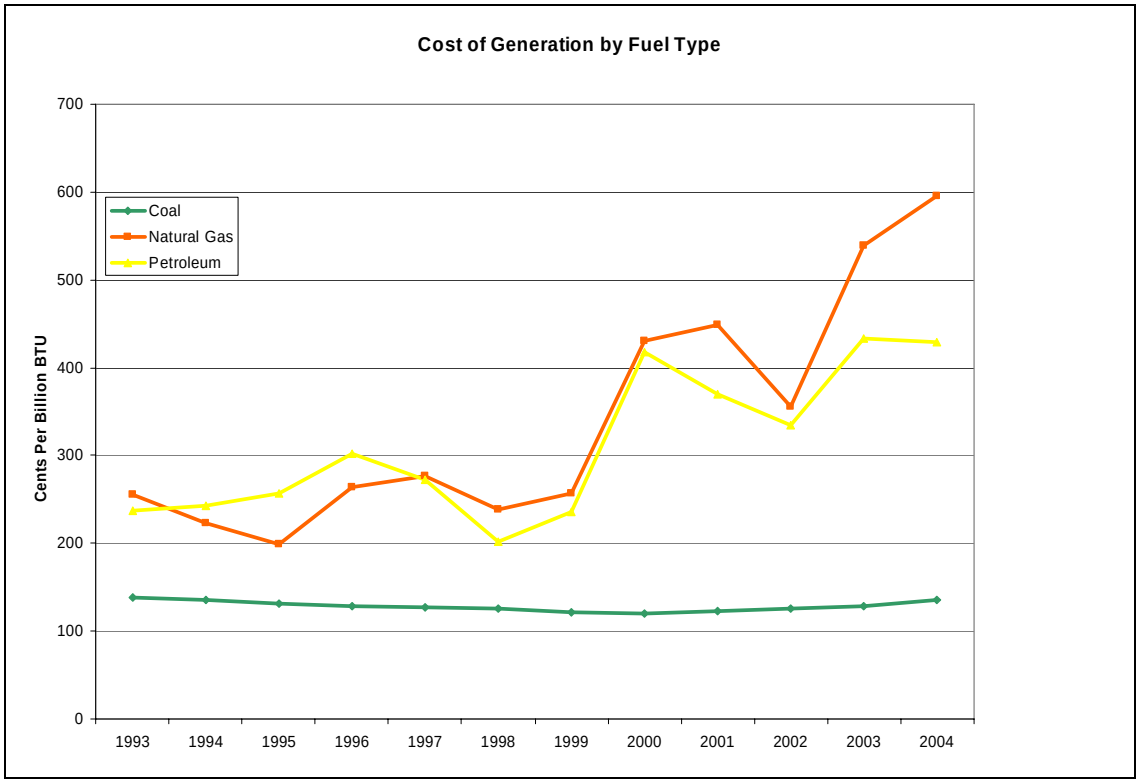
Prior to PA 141, electricity was provided as a bundled service. Incumbent utilities charged a rate that covered the generation, transmission, and distribution of power. PA 141, however, required incumbent utilities either to divest their transmission facilities or join a multistate regional transmission organization approved by the FERC. PA 141 also required regulated utilities to unbundle these services and provide electric bills that break out the costs of generation, transmission, and distribution. The functional separation of previously integrated services will allow small AESs to compete with larger incumbent utilities by permitting customers to use alternative generation suppliers. In addition, the disaggregated electric bills provide customers with more complete information to make informed decisions in choosing an energy supplier.

NATURAL GAS PRICES

Most AESs active in Michigan utilize natural gas power plants or purchase energy from the wholesale market from producers (including Consumers and Edison). For the AES-owned generation facilities, the cost of producing electricity is often determined by the current market price for natural gas. Thus, while these power plants are cheaper to build than coal-fueled plants, they are inherently more susceptible to changes in the market for

natural gas. Michigan's regulated utilities, however, rely more heavily on coal-powered plants, which are costly to build and difficult to site, but significantly less expensive to operate. Exhibit 3 highlights the difference in the cost of fuel for electric production. As the exhibit clearly shows, natural gas—which has been more expensive than coal since 1992—has dramatically increased in cost since 1999.

EXHIBIT 3
Cost of Generation, by Fuel Type



SOURCE: Energy Information Administration, Form EIA-423, "Monthly Cost and Quality of Fuels for Electric Plants Report," Federal Energy Regulatory Commission, FERC Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants, November 2005.

If AES rates continue to rise in concert with price changes in the wholesale electric market (not to mention natural gas prices) while regulated utilities' rates fall as the residential subsidy potentially ends, the development of a large number of viable electricity suppliers may be significantly hampered.[18] Economic theory suggests, however, that one of two things will happen. If coal-powered incumbent utilities are able to generate an economic profit, a coal-powered AES attracted to that profit could emerge. As will be discussed later, the construction of a coal-powered plant will be difficult and costly in either a totally deregulated environment or Michigan's current regulatory environment because of increased uncertainty about revenue streams; no capital (or at

[18] While the December 22, 2005, rate case did not begin a process of de-skewing, it is hard to imagine the continuation of subsidized rates in a quasi-competitive environment. Either some changes must be made to the subsidization process or to the choice program.

least no affordable capital) will be available without long-term contracts for power or a guaranteed customer base. This uncertainty will, most likely, decrease the bond rating for such construction and increase the costs. But the potential profit available to the operator of such a plant (coming from the spread between the costs of producing electricity with natural gas versus coal) may attract such new entrants to the market. The other possibility is that no new entrant will emerge because regulated utilities are not generating an economic (as opposed to accounting) profit. In either case, economic theory suggests the threat of competition will act as a market force to lower prices even without the physical presence of an alternative.

OBLIGATION TO SERVE

A significant benefit of the regulated natural monopoly framework is the reliability of the service provided. Regulated utilities accepted an obligation to serve all customers willing to pay the regulated rates. In addition, customers received a reliable power supply at predictable rates. As competition emerges, will incumbent utilities be forced to continue this obligation to serve without any similar obligation among AESs? Allowing this uneven playing field to continue will be a significant hindrance to a competitive market for electricity. The obligation to serve requires regulated utilities to maintain excess generating capacity for customers who may never return from the choice program. In this way the obligation operates as an implicit tax on regulated utilities with the burden of the tax being determined solely by the fact that these utilities were formerly regulated monopolies.

Under a true deregulated framework, obligation to serve by the incumbent utility switches from an obligation to *provide* and deliver power to an obligation to *connect* and deliver power from alternative sources to customers. This switch would allow incumbent utilities to maintain the same competitive advantage currently enjoyed by AESs—that is, an ability to provide power for their current and *likely* customers without having to provide power for all *possible* customers. In Michigan, however, generation was not deregulated and the regulated utilities are still required by the MPSC to provide service for all customers. With adequate notice, choice participants have the right to return to the full service at regulated rates. The terms by which a choice customer may return to the incumbent utility are critical to the ability of incumbent utilities in Michigan to effectively compete against AESs. If they are required to maintain excess capacity for all customers in their service area or buy at market prices upon the return of choice customers, it will lead to inefficiencies, thereby increasing costs and making it more difficult for them to be price competitive with AESs.

The ultimate resolution of the obligation to serve issue must reflect the determination of a broader public policy decision. Prior to PA 141, Michigan's obligation to serve was a mutual agreement: customers were obligated to purchase electricity from the regulated utility, and the utility was required to serve all customers with rates approved by the MPSC. After PA 141, Michigan has attempted to have the benefits of competition (lower short-term prices) combined with one of the benefits of a regulated monopoly (affordable, long-term, reliable access to power), but the obligation to serve has shifted. Customers—especially commercial and industrial customers—can choose from a number of electricity suppliers, but the regulated utilities are still required to serve all *potential*

customers in their area with rates approved by the MPSC. This attempt at the "best of both worlds" is unsustainable, and thus policymakers must decide on their ultimate priorities regarding the future of the electricity generation and distribution market in Michigan.

RELIABILITY

Another benefit of a regulated natural monopoly is the significant increase in reliability over an unregulated market system. Natural monopoly utilities, with a guaranteed customer base and maximum allowed profit margin (and thus no competitors pushing them to cut costs) easily achieved fully reliable service through significant and regular expenditures on things such as customer service and maintenance. Under a competitive market, however, these are the first areas that utilities feel they can easily cut. Thus, a competitive market *can* lead to decreased reliability for consumers. An interim report from the Department of Energy states, "In anticipation of competitive markets, some utilities have adopted a strategy of cost cutting that involves reduced spending on reliability … the overall effect has been that the infrastructure for reliability assurance has been considerably eroded."[19]

In Michigan, the mixed nature of the market—incumbent utilities that retain an obligation to serve and AES competitors that do not—creates incentives that exacerbate this problem. Forced to maintain capacity for customers that may never return from the choice program while simultaneously attempting to price-compete with AESs requires incumbent utilities to cut costs through decreased employment levels and expenditures on maintenance services. In many ways the reliability of the natural monopoly system comes from an implicit forced insurance program paid for by customers. Higher costs incurred under a natural monopoly system are required to fund the redundant generating capacity necessary for fully reliable service. Decreased reliability is not, per se, a negative outcome if customers face lower prices that outweigh the costs from increased reliability risks. Policymakers must decide if the increased costs are justified by the benefit of the increased reliability of a natural monopoly system.

Another reliability issue is the maintenance of adequate reserve capacity to maintain dependable electric supply. Currently, the Midwest Independent Transmission System Operator system only requires AESs to maintain a reserve ratio of 4 percent, which is much lower than the 10 to 20 percent reserve ratio generally maintained by Michigan's regulated utilities.[20] In addition, the MPSC does not have the authority to require AESs to maintain adequate reserve capacity. By granting such authority to the MPSC, lawmakers could create increased reliability for all utilities. As long as the reserve requirements are different for AESs and regulated utilities, those requirements become another barrier to a truly competitive market. Regardless of what the proper reserve level is, applying the same reserve ratios to all electric producers does not infringe on competition.

[19] United States Department of Energy, "Interim Report of U.S. Department of Energy's Power Outage Study Team," DOE, January 2000.
[20] Michigan Public Service Commission, "Status of Electric Competition in Michigan," January 31, 2005.

INCREASING ELECTRICITY DEMANDS

The recently completed Capacity Needs Forum (CNF) estimates that electric power demand in Michigan will increase at a rate of 2.1 percent a year over the next 20 years. In order to meet this growing demand, the CNF recommends (among other things) the construction of one, and possibly two, baseload coal power plants in the state.[21] No major power plant has been constructed in Michigan in the last 16 years.[22] In November 2005, Edison speculated about its potential interest in constructing a new baseload plant, but cautioned that the regulatory framework established under PA 141 may hinder its ability to participate in such a project.[23] When the project received MPSC approval, previous construction of such plants by regulated utilities was financed through bonds that were paid off by a guaranteed revenue stream generated by increased rates for electricity. The expense of building these baseload plants is one of the primary justifications for a regulated natural monopoly framework. With a specified return on investment, utilities were willing to undertake the risk involved with building capital-intensive generating plants costing billions of dollars. The construction of these plants was viewed as a public good.

Under a deregulated framework, however, it is not clear what utility (if any) would be willing to undertake the risk involved in the construction of these facilities. Without the assurance of a defined service area and the predictable and sustained return on investment, it would be significantly more difficult to obtain the financing necessary to construct a capital-intensive baseload generating capacity. According to the CNF, "a new baseload generating plant is unlikely to be financed or built without ratemaking changes to support construction."[24]

While uncertainty does decrease the likelihood of capital-intensive plant construction, if these plants (with their low operating costs) allow producers to receive prices comparable with natural gas–powered merchant plants, it is possible that someone will undertake the risk involved with the construction. It is clear that if this were to occur, such construction would be more costly than under a regulated framework due to higher financing costs brought about by uncertainty.

ADDITIONAL FUTURE SCENARIOS

There are several potential scenarios that could dramatically alter the electricity generation and distribution market moving forward and thus change any analysis of the effect of PA 141. These additional scenarios are beyond the scope of this analysis, but are presented here for purposes of discussion.

The first scenario is that one or both of the incumbent utilities is taken over by a utility from outside of the state. The changes in revenue streams brought about by PA 141—and

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[21] A baseload power plant is a plant that continuously operates and provides the minimum level of power needed by the system. These plants are highly capital intensive but have low operating costs. In Michigan, baseload power plants are either coal or nuclear. They are continuously operated regardless of spikes in demand.

[22] Hornbeck and Cain, "Energy Choices Falter in Michigan."

[23] *Electric Power Daily*, "Edison Mulls New Baseload Plant in Michigan," November 9, 2005.

[24] George Stojic, "Final Report of the Capacity Needs Forum: Memorandum," January 3, 2006, p. 2.

the geographic scope of Michigan's two largest regulated utilities—together with the repeal of the Public Utility Holding Company Act (PUHCA) have caused some analysts to believe that Michigan's public utilities are now potential targets for takeover. This could lead to increased pressure to cut costs in the maintenance and operations portion of the utility as well as to strip Michigan of some of its political leverage against a larger electric company with headquarters in a different state.

A second potential scenario is a change in the current spread between the cost of natural gas and coal prices. As long as natural gas remains significantly more expensive than coal, the ability of AESs to achieve long-term market share is hampered. On a cost-competitive basis, these providers—who are almost entirely dependent on natural gas production—are less attractive than incumbent utilities and their coal-fired plants. Similarly, if the difference in price between long-term generation contracts and higher short-term/spot market prices remains, AESs that purchase electricity from the wholesale market will also be less attractive on a cost-competitive basis. If this spread changes, the dynamics of this competition will be significantly altered. Either way, it is clear that a significant external factor to the Michigan electric market will be these fuel prices.

Has PA 141 Worked?

Judging the efficacy of PA 141 truly depends on the metric. For example, if the question is: Has PA 141 lowered residential electric rates? The answer in terms of real prices and the short term is unequivocally "yes." Rates for residential customers were immediately lowered in 2000 by PA 141 and then frozen or capped through the end of 2005. Thus, in real terms, residential customers have been economically better off over this period. But this rate freeze is clearly not a long-term means of creating lower electric rates. Upon the expiration of the residential rate cap, these customers were subjected to their first rate increases in six years. In addition, if the rate de-skewing process eventually begins, these residential customers may see greater increases in their rates than would have existed absent PA 141 (assuming no de-skewing occurred).

Judging PA 141 by its short-term effect on residential prices is, at best, an incomplete analysis of the success of the program. A more accurate question is: Has PA 141 lowered residential rates through competition? The answer here is unequivocally "no." In Michigan, regulated rates in the residential market were shielded from any competitive influences by skewing and the rate cut and cap. Thus it is not clear what will happen when or if AESs are inevitably enticed into the residential market. As the rate cap is removed and de-skewing occurs, more market incentives will be created, and for the first time there should be a real opportunity for residential customers to participate in the choice program.

While some regulated utilities argue that residential customers will never be attractive to an AES because of their low electricity usage compared to larger business customers, residential customers could make themselves more attractive to AESs by aggregating into blocs of customers who will switch suppliers. These blocs could naturally spring from already existing organizations such as neighborhood associations, subdivisions, or even small local-government entities.

Despite the fact that choice has not substantially affected residential customers, nearly 15 percent of business sales in 2005 were from alternative energy providers. This is a significant change from the pre-PA 141 world, and this shift has gotten the attention of the incumbent utilities. Currently, the jury is still out on whether the same number of firms will remain in the choice program in the absence of credits and rate skewing and whether this competition will ultimately lead to lower prices and increased efficiency in Michigan's electric market. Recent rate decisions by the MPSC eliminating the credits and allowing incumbent utilities to impose fees on all customers, regardless of whether they are bundled or choice customers, will make it more difficult for AESs to compete for business customers. In addition to the MPSC rate decisions, rising fuel costs have currently made AESs a less attractive alternative for customers and recent evidence points to a decline in market share for AESs.

Conclusion

Overall, it is clear that PA 141 is a flawed attempt at restructuring Michigan's electricity market. While the flaws stem from many sources, a primary source is the incomplete nature of the reform. In an attempt to garner the benefits of a free-market system while shielding Michigan residents from any potential costs, PA 141 only serves to create an economically unsustainable system. The challenges presented by the legislation have been exacerbated by the MPSC's early implementation decisions, in which explicit attempts to develop artificial incentives for consumers to move to the choice program were combined with a long-standing price distortion in the form of skewed regulated rates.

The recent attrition of customers enrolled in the choice program following the end of some of these MPSC-developed incentives suggests that at least a portion of the success of the choice program (as measured by the number of customers participating) was due to artificial incentives and not actual competition.

At this time, we are unable to state definitively whether the choice program has been a success. In the residential sector, customers recently experienced their first regulated rate increase since the passage of PA 141. The price increases occurring over the next several years, combined with the potential de-skewing of rates, may allow the choice program to become a viable alternative for residential customers. It is unclear, however, whether this market will develop, because wholesale market-based and natural gas–based AESs may be unable to effectively price-compete with regulated utilities without the presence of MPSC-developed incentives.

It is clear, however, that policymakers in Michigan have some critical decisions to make regarding the future of Michigan's electric market. Going forward, it is unsustainable to have a portion of the firms in the market face an obligation to serve all potential customers while others do not. If policymakers truly wish to have a competitive electric market in the state, they must be willing to allow the introduction of risk through the removal of the obligation to serve at least for customers that leave regulated providers. This will, most likely, result in a less reliable but also more competitive and fairer electric market. If, however, policymakers are not willing to accept these risks then they should take steps that move the state toward a more traditional regulatory framework.

Michigan Municipal Electric Association

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April 25, 2013

John D. Quackenbucsh
Chairman
Michigan Public Service Commission

Steve Bakkal
Director
Michigan Energy Office

Re: Readying Michigan to Make Good Energy Decisions

Dear Gentlemen:

The Michigan Municipal Electric Association (MMEA) is Michigan's trade group for municipally owned electric utilities. The 41 communities in MMEA own and operate their own electric utilities provided for approximately 8% of Michigan's total electric retail sales in 2011.

Cities or villages with municipal electric systems provide electric service to their residents, just as communities commonly provide water and sewer service. As units of local government, municipal electric systems are non-profit, community owned and operated, and regulated directly by the community they serve through elected and/or appointed officials. As such, every citizen is an owner of the utility - having the opportunity to have a direct say in decisions that affect rates, service, and policy.

The benefits produced by public power stay in the local community – whether in the form of lower rates, increased electric reliability, and financial and non-financial contributions made to the community. Nearly all MMEA members have been in existence for over 100 years.

MMEA is appreciative of the opportunity to participate in the February 14, 2013 public forum hosted by yourselves on behalf of Governor Snyder, who charged you with this responsibility during his Energy & Environment address on November 28, 2012.

In addition to the public forums, a website has been established at www.Michigan.gov/energy for the purpose of collecting information on Michigan's Energy Future. Titled *Readying Michigan to Make Good Energy Decisions* the questions focus on three main areas: electric choice, renewable energy, and energy efficiency.

The MMEA Board of Directors was given the courtesy of reviewing answers presented by a utility coalition made up primarily of DTE Energy, Consumers Energy, and members of the Michigan Electric and Gas Association (MEGA). MMEA appreciates this gesture, and would like to recognize and thank the utility coalition for the time and effort put into preparing their responses.

Where the utility coalition has provided factual information, MMEA finds the information useful, and to the best of our knowledge accurate.

Instead of joining the coalition in their response, MMEA thought it would be best to provide you with our thoughts and concerns regarding the three main areas of interest: electric choice, energy efficiency, and renewable energy.

Electric Choice

In 2006[1] and 2007[2], MMEA and Protect Michigan[3] jointly retained Public Sector Consultants[4] for the purposes of conducting studies that focused on the market structure for electricity in Michigan. While the facts are out-dated, MMEA believes that much of the information related to problems associated with a deregulated market is still relevant today.

In reviewing the 26 questions related to electric choice, MMEA believes that the answer to question #7 put forth by the utility coalition best represents the concerns of our members. Following is Electric Choice Question #7 and the response of the utility coalition supported by MMEA.

> Electric Choice Question 7: What has been the experience of other states in terms of meeting capacity needs under various market regimes (i.e. fully regulated, partially restructured, and restructured)?
>
> > Regulated models support a long-term investment planning process that ensures capacity is available for future reliability at reasonable cost-of-service and that the overall generation portfolio provides for fuel diversity and other needs such as environmental protection.
> >
> > Electricity is fundamentally different from most other industries and products and its unique characteristics require the electric system to have a margin of safety to ensure reliability. The reliability of the electric system is a public good that benefits everyone by supporting a strong and stable economy, protecting health and safety, and providing other intangible benefits.
> >
> > Public goods tend to be under-produced and under-invested in under free market conditions, producing market inefficiency. Economic theory supports government regulation to ensure sufficient production of a public good such as electric reliability. Without sufficient investment in reliability, we risk facing brown- or black-outs, with potentially drastic societal and personal consequences.
> >
> > The full extent of the challenges of meeting capacity needs under deregulation has not yet been experienced. The country has had an oversupply of generation and reductions in load due to recession. These conditions have masked the difficulty of building new generation under a deregulated model. This challenge will become more apparent as we try to invest in new generation in the future.

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[1] Electricity Restructuring in Michigan: The Effects to Date of Public Act 141 and Potential Future Challenges
[2] Market Structures and the 21st Century Energy Plan
[3] Protect Michigan is a 100,000-member strong coalition of labor organization members, business leaders, and energy industry experts, formed during the 1990s to educate Michigan citizens about electric utility deregulation.
[4] Public Sector Consultants Inc. is a private Michigan corporation providing policy research in the areas of health, education, economics, the environment, and technology; survey research; program evaluation; and strategic planning.

Texas, a deregulated state, is facing reliability issues as the deregulated ERCOT model has not effectively supported new generation investment to meet capacity needs. New Jersey and Maryland, deregulated states, have required state-sponsored contracts for new generation to address reliability concerns, as the deregulated PJM model has not incented sufficient new generation investment.

> *"Because the wholesale market conditions in ERCOT have not been favorable due to the fleet makeup and low electric prices, investment appears to have stalled. This lack of investment threatens resource adequacy in the near future"*

Source: The Brattle Group, "ERCOT Investment Incentives and Resource Adequacy" June 2012

The challenges of investing for reliability in a deregulated market will become more apparent – as in Texas, New Jersey, and Maryland – as we try to invest in new generation in the future given retirements of aging coal plants, a transition toward new and cleaner generation plants, and the return of load growth.

In 2008, the Michigan legislature recognized the longstanding history and success that local control plays in allowing customers of municipally owned utilities to have input into the decision making process. Accordingly, in crafting PA 286 the legislature allowed the governing bodies of municipal utilities to decide whether to allow retail open access for their utility [see MCL 460. 10Y(1) below]. To date, no MMEA members have opted to implement an open access model.

> **460.10y Municipally owned utility; requirements.** (1) The governing body of a municipally owned utility shall determine whether it will permit retail customers receiving delivery service from the municipally owned utility the opportunity of choosing an alternative electric supplier, subject to the implementation of rates, charges, terms, and conditions referred to in subsection (5).

For the aforementioned reasons, MMEA supports the present language contained in 2008 PA 286 Section 10y.

<u>Renewable Energy</u>

The commitment of MMEA members to invest in renewable energy is based on a long-standing commitment to citizen/customer priorities such as cleaner energy. The Lansing Board of Water & Light was the first utility in Michigan to commit to a renewable energy standard, and it was Traverse City Light & Power that built the first utility scale wind turbine, which was fully subscribed to through a voluntary premium by supportive customers.

All MMEA members, with the exception of two, are on schedule to meet the 10% renewable energy standard by 2015. The reason two members are unable to meet the standard is due to the rate caps being based on a per customer basis, while PA 295 renewable standards are based on total retail sales. If a utility has a few large customers providing a large percentage of the retail sales, but the utility can only collect a per meter charge, then that utility may not be able to meet the standard without exceeding the rate caps. This is more likely to happen with smaller utilities.

MMEA members would urge policy makers to proceed with caution when consideration is given to increasing the 10% standard. MMEA members will always seek the best value when deciding what generation to invest in, and renewable energy will remain an important part of our generation portfolio.

However, government mandates can have the unintended consequence of driving up the price of renewables by sending signals to renewable developers that utilities have no other viable option of generation (to meet the mandate or threshold). The lower the cost of renewable generation, the more of that generation type utilities will purchase.

In addition, policy makers need to consider several of the issues stated in the utility coalition response to Renewable Energy Question 5. Transmission, back-up capacity, and integration of intermittent resources to the electric grid are costs that many times are hidden in the final rate paid by the customer.

MMEA and its customers support renewable energy today, and will continue to do so going forward. However, it is our belief that our customers through input to their local governing bodies, is a preferable method of driving investment in renewable generation visa vie government mandate.

Energy Efficiency

To date, municipal utilities have been able to meet the energy savings goals as required by 2008 PA 295. However, it has become apparent that it will become more challenging to meet these requirements/goals going forward due to changes in appliance and lighting standards, together with the implementation of the most cost effective measures by early adopters ("low hanging fruit"). In the future, implementing energy efficiency measures will become more expensive, and thus, municipals will be less likely to achieve the savings goals while remaining under the spending caps (2012 initial annual report results are showing between 25-30% of the municipals did not meet the energy savings goals).

The MPSC has recognized a need to provide flexibility to small utilities as shown in case number U-17008. MMEA appreciates this recognition by the Commissioners, and commends MPSC staff for their effort in working with MMEA members to implement energy efficiency measures. Given that municipals are locally regulated, MMEA believes that after 2015 state public policy should allow MMEA governing bodies to determine what goals and program offerings are best suited for their customers. As not-for-profit utilities, it will always be in the utility's best interest to invest in energy efficiency when it less expensive (and more environmentally friendly) than new plants or purchasing from the wholesale market.

Again, on behalf of our 41 members, the MMEA Board would like to thank Governor Snyder for his leadership in Readying Michigan to Make Good Energy Decisions, and thank both of your for carrying out your charge in such a exceptional manner.

Please contact me should you have any questions regarding our submission.

Regards,

Jim Weeks
Executive Director

C: MMEA Members