STATE OF IOWA
DEPARTMENT OF COMMERCE
BEFORE THE IOWA STATE UTILITIES BOARD

IN RE: **APPLICATION OF MIDAMERICAN ENERGY COMPANY FOR A DETERMINATION OF RATEMAKING PRINCIPLES**	:	**DOCKET NO. RPU-2014-0002**

DIRECT TESTIMONY
OF
NEIL D. HAMMER

Q. Please state your name and business address for the record.

A. Neil D. Hammer, 4299 Northwest Urbandale Drive, Urbandale, Iowa 50322.

Q. By who are you employed and in what position?

A. I am employed by MidAmerican Energy Company as Director, Market Assessment.

Q. Please describe your responsibilities as Director, Market Assessment.

A. I am responsible for overseeing the electric market price forecasts, fuel market projections, resource planning and evaluation, electric transmission analyses and environmental modeling.

Q. Please describe your education and business experience.

A. I graduated from Iowa State University with a Bachelor of Science degree in Electrical Engineering in 1988 and from St. Ambrose University with a Masters of Business Administration in 1998. I joined Iowa Illinois Gas and Electric, a predecessor of the Company, in 1989 as an Engineer in the transmission and distribution planning department. During my career, I have worked in Electric

System Planning (1989-1995), Transmission Services (1995-2000), and Electric Trading (2000-2013). In 2013, I was promoted to my current position.

PURPOSE OF TESTIMONY

Q. What is the purpose of your prepared direct testimony?

A. The purpose of my testimony is to address various aspects of MidAmerican's Application for a Determination of Ratemaking Principles ("Ratemaking Principles Application") concerning the Company's proposal to develop 162 MW of new wind power generation—the Wind IX Iowa Project ("Wind IX"). In the course of my testimony, I address the following topics, including the four (4) topics that are covered by the Board "subrules" mentioned in the first four (4) bullet points, below:

- Projected typical annual hours of operation, output and capacity factors for Wind IX in response to subrule 41.3(1)"c" (See pp. 3 - 5, below);
- Impact on Fuel Diversity and Use of Non-traditional Supply Sources in Iowa in response to subrule 41.3(4) (see pp. 5 -6, below);
- Impact on Electric Supply Reliability in response to subrule 41.3(4). This subject is addressed in my testimony (see pp. 16 -18, below), as well as in the testimony of MidAmerican witness Peter Schuster;
- MidAmerican's Consideration of Wind and Other Long-Term Supply Options in response to subrule 41.3(6) (see pp. 6 - 44, below). This is the bulk of my testimony, below, and includes my consideration of the following topics which comprise parts of MidAmerican's resource selection process: (A) Meets Customer Needs, (B) MidAmerican's Long Term Supply Options, (C) Nine-Factor Reasonableness Analysis, (D)

Comparing Wind Generation to other Options Using the Nine Reasonableness Criteria, (E) Summary of the Nine Factor Analysis, (F) Wind vs. Conventional Generation Operating Characteristics, (G) Feasible Renewable Generation Options, (H) Selection of Wind Generation, and (I) Future Capacity Requirements.

I will also describe the analysis performed under my direction of MidAmerican's power production costs that MidAmerican witness Mark Yocum uses to conduct his customer impact analysis for Wind IX. This includes a discussion of production cost modeling, MidAmerican's assessment of financial impacts arising from future carbon regulations as pertaining to wind generation, and renewable energy credit values.

- Analysis in Support of Mr. Yocum's Financial Analysis. (See pp. 45 - 50, below)

(Please note: The above references to "subrules" actually refer to the Iowa Utilities Board's ("Board") proposed Chapter 41 rules that the Iowa Utilities Board did not adopt, but that remain available for utilities to consider in formulating ratemaking principles filings.)

PROJECTED HOURS OF OPERATION FOR WIND IX (41.1(1))

Q. Please describe the projected hours of operation for Wind IX.

A. Hammer Exhibit __ (NDH-1), Schedule 1 contains a projection of Wind IX's annual hours of operation, energy output and capacity factor, based on a projected 162 MW of new wind generation. This Schedule is in response to paragraph "c" of the proposed Iowa Utilities Board subrule 41.3(1). The actual hours of operation, output and capacity factor will depend on factors such as the final location of Wind IX farms and turbines. Based on the above projection, and our experience at MidAmerican's existing wind power projects, I expect Wind IX will operate approximately 8,200 hours annually at an expected overall combined average capacity factor of 36.8% when fully developed. The actual operation will vary from one year to another based on the wind resource, scheduled maintenance, forced outages, possible transmission system operating guides and economics.

Wind-powered generation is largely dependent on the wind as a fuel source, and hence, is not dispatchable in the traditional sense of conventional generation.[1] (Historically "dispatchable" referred to a utility's ability to increase or decrease energy production without tripping the unit offline as demand for energy varied.) Therefore, the operating characteristics for each Wind IX site must be estimated from meteorological data applied to the wind turbine power curve,[2] and then adjusted for the wind power projected losses.[3] The process of modeling the above-mentioned projections for Wind IX differs from similar projections for non-intermittent, dispatchable electric generating units (e.g., coal or gas-fired). While the Midcontinent Independent System Operator, Inc. ("MISO") allows intermittent resources (e.g., wind generation) to be

[1] To address concerns with the intermittency of the wind resource, the Midcontinent Independent System Operator, Inc. developed a Dispatchable Intermittent Resource ("DIR") methodology that allows intermittent resources such as wind to be managed in a manner that regional system requirements can be optimized. Wind generators are allowed to submit an offer stating that the unit(s) can be dispatched economically as the intermittent resource permits.

[2] The wind turbine power curve is the relationship of the generator output to the wind speed. This relationship is uniquely defined for each individual type of wind turbine based on its design.

[3] Operating characteristics for a wind power project include wake and array losses (i.e., the impact one wind turbine has on another as a result of the direction of the wind and the relative positions of the turbines), icing and blade degradation, electrical losses (collector system, generator step-up transformer and interconnection line), parasitic losses (FAA lighting, project lights, cold weather heaters, etc.), power curve losses, availability (scheduled and forced outages), high speed hysteresis, high speed shutdown, cold weather impacts, control losses, collector substation maintenance, and other events.

economically dispatched, wind generation is dependent on the level of wind resource available above a base threshold, whereas, the operator of traditional generation has control of the full resource. Therefore, the process of modeling wind is based on dispatching an expected wind-based output profile against a price curve with the dispatch prices as the only limitation to operation.

FUEL DIVERSITY AND USE OF NON-TRADITIONAL SUPPLY SOURCES (41.3(4))

Q. Please describe your fuel diversity analysis.

A. I have provided the information requested by paragraph "d" of proposed subrule 41.3(4) (Fuel Diversity and Use of Nontraditional Supply Sources). This includes an analysis of Wind IX's impact on the fuel diversity of MidAmerican's generation system. It also includes a description of Wind IX's impact upon MidAmerican's use of non-traditional supply resources.

Q. How is the fuel diversity of MidAmerican's generation system impacted by Wind IX?

A. Table 1 illustrates the fuel diversity of MidAmerican's current generation system before and after construction of the nominal 162 MW of Wind IX. The addition of Wind IX further diversifies MidAmerican's portfolio, reducing MidAmerican's percentage of coal-fired nameplate capacity by about 0.5% in 2016.

Table 1

MidAmerican Energy Company Fuel Diversity Based on Summer Accreditation for MISO Planning Year 2014-15		2014 Fuel Diversity		2016 Fuel Diversity							
		Installed Capacity		Installed Capacity Pre Wind IX		Installed Capacity Post Wind IX		Nameplate Pre Wind IX		Nameplate Post IX	
		(MW)	%	(MW)	%	(MW)	%	(MW)	%	(MW)	%
Nuclear		454	8.4%	454	8.7%	454	8.7%	505	5.7%	505	5.6%
Coal		3,350	61.9%	2,858	54.8%	2,858	54.8%	2,872	32.6%	2,872	32.1%
Natural Gas		1,267	23.4%	1,267	24.3%	1,267	24.3%	1,622	18.4%	1,622	18.1%
Oil		56	1.0%	56	1.1%	56	1.1%	56	0.6%	56	0.6%
Wind	[1]	304	5.6%	307	5.9%	307	5.9%	3,465	39.4%	3,627	40.5%
Hydro		1	0.0%	1	0.0%	1	0.0%	4	0.0%	4	0.0%
Methane		8	0.1%	8	0.1%	8	0.1%	8	0.1%	8	0.1%
Purchase(+)/Sale(-)	[2]	(24)	-0.4%	265	5.1%	265	5.1%	265	3.0%	265	3.0%
Total	[3]	5,415	100.0%	5,215	100.0%	5,215	100.0%	8,796	100.0%	8,958	100.0%

1 - Wind generation online as of June 30, 2014 plus the Buena Vista wind Farm purchase. Wind values are based upon summer accredited MISO capacity rather than installed capacity. The 2016 wind capacity values do not include future Wind VIII and Wind IX projects in the ICAP values, subject to completion of MISO studies, but they are included in the 2016 nameplate values.
2 - Includes forecasted purchase per the load and capability forecast with unknown mix of fuel
3 - Individual totals may differ due to rounding.

Q. What impact would Wind IX have on MidAmerican's use of non-traditional supply sources?

A. Wind IX's 162 MW would increase MidAmerican's use of renewable nameplate capacity sources by 4.7% above the 3,477 MW of existing and under development renewable nameplate capacity (wind, hydro, and methane in Table 1), including purchases on its system, to 40.6% of total MidAmerican nameplate generating capability.

MIDAMERICAN'S CONSIDERATION OF WIND AND OTHER LONG-TERM SUPPLY OPTIONS (41.3(6))

Q. Please describe the process you follow in considering long-term supply options, including wind generation.

A. In this section of my testimony I will address the process I have used in considering Wind IX, and other potential long-term supply options for addition to MidAmerican's system. As is demonstrated below, I have ultimately selected Wind IX as a reasonable long-term supply option due to the many customer needs Wind IX will address.

A. WIND IX – MEETS CUSTOMER NEEDS

Q. Why do you believe construction of Wind IX is a reasonable step for MidAmerican to undertake?

A. MidAmerican is a state rate-regulated utility with a service obligation to provide for its customers electric needs. That obligation includes prudently planning to provide reasonable and adequate electric service and facilities to its customers, as measured by a variety of customer needs, at just and reasonable rates. MidAmerican engages in a number of prudent measures to ensure that it meets customer needs both in the short and long term. These needs of customers include, without limitation, the following:

- Environmental compliance needs: Increasing the supply of zero-emissions electricity to meet expected future regulatory requirements limiting carbon and other emissions and effluents;
- Customer pricing needs: Providing revenue streams, and avoided costs that are likely to offset the costs of Wind IX and provide a source of energy that can displace energy from carbon-based generation resources;
- Fuel diversity needs: Reducing dependence on fossil fuels and insulating customers from more volatile fuel-cost sources of energy and potential fuel transportation cost changes;
- Economic development needs: Promoting economic development in Iowa;
- Iowa energy policy needs: Supporting Iowa's role as a renewable energy leader; and
- Energy needs: Increasing the supply of low cost energy.

The proposed Wind IX project is expected to meet all of these customer needs. Also, Wind IX has the potential to reduce projected capacity deficits, although the capacity value is not a part of the financial benefits analysis since the MISO interconnection studies that may make these resources eligible as capacity resources are ongoing.

Stated in greater detail, the needs are as follows:

Environmental Compliance. Wind IX offers potential environmental benefits including: 1) supports compliance with current and projected environmental regulation requirements, 2) mitigates expected federal regulations that implement greenhouse gases ("GHG") permit limits based on post-control installation criteria, and 3) provides assistance with potential limits on GHG emissions from existing fossil-fueled electric generating plants. Witness Jennifer McIvor addresses the environmental benefits more fully in her testimony.

Customer Pricing. Wind IX can be developed at a reasonable cost when compared to other feasible alternative sources of supply. As MidAmerican witness Yocum testifies, MidAmerican projects that it will be able to provide customers with Wind IX at no net cost.

Fuel Diversity. Wind IX also reduces dependence on fossil fuels and customer exposure to more volatile fuel-cost sources of energy and potential fuel transportation cost changes.

Economic Development. In addition, wind generation promotes economic development and provides value to rural areas. Witness Adam Wright addresses these benefits further in his testimony.

Supports Energy Policy. Moreover, Wind IX is consistent with Iowa's stated public policy to encourage renewable energy resource development in Iowa, as MidAmerican witness Adam Wright testifies.

The state of Iowa, with 5,177 MW, is currently third behind only Texas (12,354 MW) and California (5,829 MW) in the amount of nameplate wind capacity installed as of the fourth quarter of 2013.[4] However, Iowa is number one in wind generation when it is measured as a portion of the state's total resource capacity mix. MidAmerican believes that renewable energy from wind generation, to reduce the carbon intensity of its generation resources, is good for both Iowa and the nation.

Energy Needs. Again, Wind IX is projected to have no net cost impact on customers, it meets customer requirements for low cost energy, and it mitigates the risk of fuel price volatility (e.g., natural gas) and potential fuel transportation cost changes. Wind energy is allocated to retail customers as the lowest cost energy resource, and it may provide capacity value as explained further in my testimony.

Benefits Summary. Since Wind IX satisfies many of the needs that comprise MidAmerican's obligation to serve customers with electric energy at just and reasonable rates, and is consistent with Iowa law and policy supporting the development of renewable generation for rate-regulated utilities, Wind IX is clearly a reasonable step for MidAmerican to take. Wind generation continues to be the most viable renewable option in the upper Midwest, including Iowa.

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[4] The nameplate wind capacity installed is based on American Wind Energy Association's "AWEA U.S. Wind Industry First Quarter 2014 Market Report" released April 29, 2014.

B. MIDAMERICAN'S LONG-TERM SUPPLY OPTIONS

Q. Please address the viability of wind generation compared to MidAmerican's other alternatives.

A. MidAmerican's alternatives to Wind IX are limited. Natural gas-fired generation is the only conventional generation that is realistically available to MidAmerican prior to the 2020s at the earliest. New coal-fired generation will only be an option if it can meet the carbon dioxide emissions limit applicable to generation sources, as proposed by the Environmental Protection Agency in January 2014.[5] To meet that standard would require some form of carbon capture. Carbon capture and sequestration technology is in its early stages of development. It remains to be determined if it is economically viable. Similarly, nuclear generation on a modular basis is not currently licensed and may not be an option for several years.

Although some forms of renewable generation are also an alternative to Wind IX, only biomass, utility scale solar photovoltaic, and hydroelectric generation are currently available on a similar scale as wind generation in the Midwest. However, both biomass and hydroelectric generation struggle with environmental issues. The EPA has not yet determined how it will regulate emissions from biomass, so its availability is also uncertain. Hydroelectric generation has also faced a number of environmental challenges. Photovoltaic solar ("PV") has made strides as a viable renewable resource as costs have decreased. While it is best suited for regions such as the southwestern U.S., some Midwest and Eastern states have included a solar requirement in their renewable

[5] *See* "Standards of Performance for Greenhouse Gas Emission from New Stationary Sources: Electric Utility Generation Units," 79 Fed. Reg. 5, 1430 (January 8, 2014). The proposal is also referred to a New Source Performance Standards or the 111(b) proposal, since the rule is issued under § 111(b) of the Clean Air Act, as amended.

portfolio standards. MidAmerican has constructed a 60 kW PV solar unit at the Iowa State Fairgrounds. While small, this unit will provide valuable data on the viability of solar power in Iowa. Currently, solar is not a viable alternative to wind generation for MidAmerican.

Q. What criteria have you used to analyze whether Wind IX is reasonable?

A. I am using the same criteria MidAmerican used with respect to Wind VIII, the 1,050 MW wind generation addition the Board approved in 2013 as a reasonable alternative for MidAmerican. I would note that the Board has previously determined both cost and non-cost factors may be considered in making a determination of what is a reasonable generation resource addition when comparing alternative sources of generation.

The nine criteria MidAmerican has identified to evaluate the attractiveness of different generation resources are: (1) cost, (2) cost robustness, (3) system reliability, (4) environmental reasonableness, (5) flexibility/optionality, (6) diversity, (7) economic development, (8) geo-political uncertainty and (9) resource availability/stability.

Although cost is considered to some degree, I have applied the nine criteria to conduct a largely qualitative analysis of Wind IX when compared to the various resource options available to MidAmerican. This analysis is a reflection of the fact that the state of Iowa recognizes that generation resource planning must be based on more than just cost-based, least cost analyses, as the Board has recognized in its prior ratemaking principles decisions, including the Board’s Wind VII “Final Decision and Order” issued on December 14, 2009 (Docket No.

RPU-2009-0003), and its Wind VIII "Order Approving Settlement and Requiring Reports" issued on August 9, 2013 (Docket No. RPU-2013-0003).

Q. Please summarize the results of the analytical process.

A. The analytical process that I have used for Wind IX is the same process used in MidAmerican's Wind VIII ratemaking principles filing.

The nine-factor qualitative analysis demonstrates that wind generation is a very reasonable resource to meet MidAmerican's and its customers' needs, based largely on wind generation's favorable performance on the following criteria: reasonable cost, environmental reasonableness, economic development, geo-political uncertainty, diversity and resource availability/stability. Furthermore, wind generation is a local renewable resource that is mature, economically viable, and in sufficient supply to make a meaningful contribution to MidAmerican's, its customers' and the state's requirements.

C. NINE-FACTOR REASONABLENESS ANALYSIS

Q. Please provide background on the methodology used for your qualitative analysis of the alternatives.

A. In general for a utility, the various power production technologies complement one another to deliver electricity economically and reliably within a diverse resource portfolio while complying with environmental requirements and minimizing future risks. Therefore, any comparison of a power production technology with an alternative must be done in context of the Company's existing assets and the broader resource market.

Electric power technologies have been traditionally classified into three general functional categories: baseload, intermediate and peaking operation.

While some types of generation can fall into more than one category depending on capability to fuel switch or operate at different levels of output, other resources do not neatly fit into any of the traditional functional areas; therefore, two new functional categories, intermittent operation and storage, have been included. Power production whose output is fully dependent upon an uncontrollable resource such as wind or solar is characterized as "intermittent." Pumped hydro, compressed air, and batteries are examples of "storage" (they are not resources per se) facilities or devices that store energy produced by other power production technologies typically during low cost periods and then release their energy during higher cost periods.

Q. How do you compare the resource alternatives?

A. I compared the various power production technologies using the above-mentioned nine reasonableness criteria. Mr. Wright's testimony establishes the reasonableness of the cost caps MidAmerican proposes for Wind IX. Mr. Yocum demonstrates that the 162 MW of Wind IX capacity can be added at a reasonable cost (projections show that it will be at no net cost to customers). I would add that wind generation performs favorably with more traditional forms of generation (largely coal, oil and gas fired generation) when evaluated in terms of future variability in fuel costs and more stringent carbon and other emissions policies.

D. COMPARING WIND GENERATION TO OTHER OPTIONS USING THE NINE REASONABLENESS CRITERIA

Q How do your reasonableness criteria compare with what MidAmerican presented in the Wind VIII ratemaking principles proceeding?

A. I use the same criteria MidAmerican used in that proceeding. My analysis below is consistent with that prior analysis. Not surprisingly the characteristics of wind generation have not changed subsequent to the Board's approval of Wind VIII ratemaking principles in August 2013.

1. COST

Q. How has MidAmerican analyzed the cost of wind generation and other generation options?

A. The costs for Wind IX are addressed by: (1) the reasonableness of the cost caps proposed for Wind IX as supported by the testimony of Mr. Wright, (2) the economic analysis addressed in the testimony of Mr. Yocum, and (3) the more immediate customer energy cost savings benefits addressed by Mr. Specketer. Messrs. Wright and Yocum have demonstrated that Wind IX can be added to MidAmerican's generation portfolio at a reasonable cost and with long-term benefits for customers, while Mr. Specketer summarizes the benefits customers will see through the energy adjustment clause.

2. COST ROBUSTNESS

Q. Please compare wind and the other technologies using the cost robustness criterion.

A. The same general cost robustness considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable. The cost robustness criterion for Wind IX focuses on gas price volatility and carbon. Fossil-fueled plants emit carbon, so policies (which are expected to continue) that address carbon emissions improve the economics for low or no carbon generation relative to fossil-fueled generation. Natural gas has experienced volatile pricing over the past half century. While gas prices remain relatively low at present, the potential for increased gas prices is greater than exists for decreased natural gas prices. I would note that in a fairly recent 12-month period the price of gas increased by 132% from a low of $1.82/MMBtu on April 20, 2012 to $4.23/MMBtu on April 15, 2013.[6] This type of price volatility has occurred multiple times in the past. Of course, higher natural gas prices favor the economics of generation using competing fuels.

Another factor is that other technologies cannot be obtained and placed in service during this limited window of opportunity. In summary, wind generation performs favorably when compared to more traditional forms of generation (largely coal, oil and gas-fired generation) when evaluated in terms of future variability in fuel costs and environmental policies that impact fuel costs.

3. ENVIRONMENTAL REASONABLENESS

Q. Please compare wind and the other technologies using the environmental reasonableness criterion.

A. The same general environmental considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable. The approach used to evaluate the environmental criterion is to gauge each technology's impacts to air and water, and each technology's byproducts. Coal-fired units receive the lowest ranking even assuming use of BACT (best available control technology) emissions controls. Even if carbon capture and sequestration technology is added to the equation, coal still ranks lower than other technologies on the environmental criterion. Mining operations, byproduct disposal and other

[6] Source: Energy Information Administration's database of Henry Hub Gulf Coast Natural Gas Spot Prices, release date 4/17/2013.

pollutant emissions (i.e., sulfur dioxide, oxides of nitrogen, and mercury) limit coal-fired technologies with respect to the environmental criterion. Gas-fired generation receives a mid-range ranking, especially for combined-cycle operation due to both carbon and, oxides of nitrogen emissions. Gas-fired peaking generation fares a little better since it typically experiences limited operation.

Nuclear generation benefits from the fact that it does not directly emit any carbon, sulfur dioxide, oxides of nitrogen or mercury emissions. Renewable generation ranks high as would be expected, with wind and landfill gas receiving the top ranking. Wind power has limited environmental impact mostly due to the impact of site preparation and the manufacturing of equipment. Landfill gas does release some emissions (e.g., carbon dioxide and oxides of nitrogen), but the more challenging issue is the release of methane gas into the atmosphere, which is a more potent greenhouse gas than carbon dioxide. Solar is an emission-free resource that depending on location has become more economic and is gaining widespread acceptance, but it may have local siting issues to contend with. Finally, biomass is encountering some opposition as a renewable resource in states like Massachusetts. In addition, the Environmental Protection Agency is developing guidelines on how biomass emissions should be regulated under existing and proposed greenhouse gas emission standards.[7] The guidelines have not been finalized, which creates some uncertainty as to biomass generation's environmental ranking relative to zero-emissions renewable energy sources.

4. SYSTEM RELIABILITY

Q. Please address the system reliability criterion.

[7] *See*, *e.g.*, 76 Feg. Reg. 139, 43490; July 20, 2011. This rule was overturned in July 2013, *Center for Biological Diversity v. EPA*, D.C. Circuit Court of Appeals, No. 11-1101.

A. The same general system reliability considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable. System reliability addresses transmission-related reliability, capacity reserve-related reliability and operational reliability. System reliability is dependent on the location of the proposed facility, the type of facility and its operating characteristics. An ongoing balance between system load and capacity must be maintained. The difference between the system load and capacity contributes to area control error. The variability of wind requires other generation to adjust so that the area control error is maintained within acceptable bounds.[8] Another facet of reliability addresses local area issues such as voltage support or transmission system improvements. The means of comparing generation technologies for system reliability centers on issues dealing with system integrity like the following:

1. Availability at the time of system peak loads;
2. Availability for spinning and supplemental operating reserve;
3. Regulation (i.e., the ability of generation to follow changes in system requirements);
4. Response to MISO energy dispatch instructions, including those for curtailments;
5. Local area support (voltage support) -- the reactive capability of a unit (i.e., a generation technology's ability to produce or consume reactive demand);

[8] MISO allows wind to be designated as a dispatchable intermittent resource based on economics.

6. Black start capability[9];
7. Transmission system improvements (development or upgrade of transmission and/or reduction of impact on, or elimination of, a transmission constraint); and
8. Power quality -- Unit actively supports power quality.

Peaking generation, especially turbines that can start in less than 10 minutes, enhances system reliability for several of the criteria listed above including: spinning and supplemental operating reserves, regulation, quick start capability for supplemental reserves, black start capability, local area protection (i.e., to maintain local system voltages within acceptable limits) and power quality. Baseload units such as nuclear and coal-fired generation also provide support for system reliability through the significant addition of outlet transmission (i.e., transmission required to deliver power from the plant to load centers), which further enhances the transmission grid. While coal-fired generation typically can follow load changes, nuclear units typically do not.

Renewable generation tends to rely more on other generation for system operation functions (e.g., following the wind variability). In fact, wind and solar add to the need for regulation and can limit the availability of other generation during low load periods. Wind generation is least likely to be available during system peak conditions due to less wind resource during that period. Landfill gas is typically connected to the distribution system, and therefore, cannot provide regional transmission support.

[9] Black start capability is the ability of a generator to start without support from the transmission system, which is not energized due to a system-wide power failure (blackout).

5. ECONOMIC DEVELOPMENT

Q. Provide an overview of the economic development benefits for each technology.

A. The same general economic development considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable. The economic development benefits criterion is a measure of the value afforded to the local area and the state of having a particular type of resource. The criteria used to measure economic development benefits include construction work force, ongoing operations and maintenance staff, creation of manufacturing facilities in the state, property tax revenues and royalties or other benefits to parties within the state.

Large plant installations such as nuclear, coal-fired units and combined-cycle plants require a large number of skilled workers to construct the plants. Smaller plants require fewer individuals, and thus, provide less benefit to the local economy during construction. While construction lasts only for a few months to a few years, plant operations are ongoing throughout the plant's life. Large facilities such as the nuclear and coal-fired plants require substantial staffing. Other plants like combustion turbines may not require any onsite staff. Wind farms typically require some ongoing staff to address the maintenance issues associated with the numerous turbines in a wind farm. On the other hand, small generating plants such as those for landfill gas are limited in location and size and provide limited opportunity for economic development.

All generating facilities if developed will provide some contribution to property tax revenues with baseload plants typically providing the most benefit, especially with Iowa's property tax formula that is based on a plant's output.

Royalties (e.g., rent) provide another form of indirect benefit to local economies, and of course, direct benefit to the recipient (e.g., landowners where the generation resource is located). Currently, wind is the primary resource that provides this benefit (i.e., payments for easements on the land where wind turbines are situated). Most other plants are located on utility-owned property, whereas wind is typically located on leased farm land. Solar may also someday provide a similar benefit in this respect.

As discussed above, the potential for work force, ongoing operations and maintenance staff, creation of manufacturing facilities in the state, property tax revenues and royalties within the state is greater for some generation resources such as wind. MidAmerican witness Adam Wright provides additional testimony on the projected favorable economic development impact of Wind IX.

6. GEO-POLITICAL UNCERTAINTY

Q. Please address the political uncertainty criterion.

A. The same geo-political uncertainty considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable. Geo-political uncertainty includes exposure to global markets and their associated volatility, geo-political instability (including terrorism), regulatory and legislative uncertainty and local public reaction to a particular type of development. Exposure to global markets can occur on at least three levels: (1) the cost of raw materials used in the manufacture of a technology may be subject to world demand, and hence price instability, (2) components of a facility could be manufactured in a foreign country and the exchange rate with the U.S. dollar could impact prices, and (3) fuel prices for natural gas, oil and coal could be driven by events in other parts of the world. Plants manufactured in the U.S. that consume fuels with little or no link to foreign markets are ranked highest. Wind is among those plants with limited exposure to foreign events. Natural gas-fired plants have more exposure to world markets as the demand for gas, foreign and domestic, increases.

Geo-political uncertainty includes the potential for terrorists to disrupt the supply of certain fuels or to target certain plants. Plants that depend on fuels available in North America, such as coal, uranium, hydro, biomass, wind and solar, are less subject to curtailment of fuel supplies due to such events in foreign countries. Therefore, plants using these resources would have a higher ranking. Another factor is the likelihood that a plant will become a target for a terrorist attack. Smaller, distributed generation-type plants, such as wind and combustion turbine peaking units, are less likely to be targets than larger plants that would have a greater impact and have a higher public profile.

As illustrated by MidAmerican witness, Jennifer McIvor, there are substantial indications of continued regulatory tightening of controls on emissions from certain sources of electric generation. For these reasons, regulatory uncertainty plays a role in plant selection. Uncertainty, such as that surrounding carbon regulation[10], or regulation of the interstate transport of emissions[11] sends signals to the industry to beware of certain technologies, or to delay

[10] The history of carbon emissions regulation is described in Jennifer McIvor's environmental testimony.
[11] The Environmental Protection Agency promulgated the Clean Air Interstate Rule ("CAIR") in March 2005; in July 2008, the D.C. Circuit vacated CAIR, but in December 2008, the D.C. Circuit remanded CAIR without vacating the rule and directed EPA to remedy the rule's flaws. In July 2011, EPA issued the Cross-State Air Pollution Rule ("CSAPR") as the replacement to CAIR; in December 2011, the D.C. Circuit issued a stay on CSAPR, and ultimately vacated the rule in August 2012. In April 2014, the U.S. Supreme Court reversed the D.C. Circuit's ruling and upheld CSAPR. The D.C. Circuit is now accepting briefs from the appellants to determine when and how the stay is lifted, as well as how to implement the rule.

implementation of certain actions possibly resulting in more risks for development and potentially higher costs for companies and their customers. Technologies for which this applies would receive low rankings in this metric.

Local public acceptance of a technology is also critical to its development. Local opposition can delay plant development and result in cost overruns. Plants that tend to have the least amount of opposition would be more highly ranked.

Wind generation ranks among the top of the technologies with respect to geo-political uncertainty with no dependence on foreign fuels, a limited target for terrorism (as opposed to a large base-load facility), minimal environmental exposure and in general a positive acceptance by the general public.

7. FLEXIBILITY/OPTIONALITY

Q. Please address how flexibility/optionality influences plant selection.

A. The same flexibility/optionality considerations applicable in prior wind ratemaking principles proceedings continue to remain applicable.

Flexibility/optionality addresses the ability of a particular technology to respond to changing conditions. The criteria for comparing flexibility/optionality focus on items such as fuel switching (e.g., coal to gas, coal to biomass, etc.), conversion to other technologies (e.g., conversion of a coal plant to a combined-cycle plant, addition of a steam generator and associated heat recovery system to simple-cycle combustion turbines, conversion of a combined-cycle facility to an integrated gas combined cycle, etc.), utilization of a wind site to add peaking units to better utilize transmission line capability, or the ability to decommission a plant at a reasonable cost.

Gas-fired plants tend to have the greatest flexibility/optionality in that they can be operated on multiple fuels, converted to other technologies or even relocated. Plants dependent on a single fuel have limited flexibility/optionality and are assigned the lowest ranking. While wind generation has little flexibility/optionality since its source of power is only wind and the turbines cannot be used for other purposes or easily moved, a wind site can be coupled with another generation resource, such as a simple-cycle combustion turbine or a combined-cycle combustion turbine to better utilize transmission.

8. DIVERSITY

Q. Please address the diversity criterion.

A. Diversity of generation resources is a key element in reducing risk and increasing reliability, and for purposes of this analysis has the following aspects: fuel type, type of technology and operational mode (baseload, intermediate, peaking, intermittent and storage). While this criterion overlaps a bit with several other criteria, it has independent importance due to its broader scope. The diversity criterion applies to both MidAmerican and the surrounding region.

MidAmerican's diversity addressed above demonstrates that additional wind diversifies the Company's portfolio by further reducing dependence on coal-fired generation. Table 2 summarizes the diversity of generation in Iowa and the surrounding states and in the U.S. portion of the Eastern Interconnect.

Table 2
Regional Generation Capacity (Nameplate Diversity by Fuel Type)

	Iowa and Surrounding States		U.S. Eastern Interconnect	
Primary Fuel	**Capacity (MW)**	**Fuel Mix (%)**	**Capacity (MW)**	**Fuel Mix (%)**
Coal	61,560	38.9%	273,513	32.8%
Petroleum Coke	152	0.1%	2,068	0.2%
Gas	47,071	29.8%	330,404	39.6%
Oil	6,531	4.1%	43,270	5.2%
Uranium	20,408	12.9%	94,473	11.3%
Other	60	0.0%	1,251	0.2%
Other Renewable	1,223	0.8%	12,526	1.5%
Solar	35	0.0%	1,570	0.2%
Water	3,984	2.5%	43,396	5.2%
Wind	17,188	10.9%	30,880	3.7%
Grand Total	158,212	100.0%	833,352	100.0%
Source: Ventyx's Velocity Suite - January 2014				

Fossil fuels comprise nearly 74% of the generation in Iowa and the surrounding states[12], and nearly 78% in the U.S. portion of the Eastern Interconnect. On the other hand, renewable generation, including hydroelectric, comprises 14.2% in Iowa and the surrounding states, and 10.6% in the Eastern Interconnect. Wind is 10.9% and 3.7%, respectively. Additional wind would decrease the carbon footprint in the region, just as it increases the diversity in MidAmerican's generation capability.

Q. Describe the regional generation market in terms of fuel considerations.

A. The prices for natural gas, oil and coal increased dramatically in 2008 before the economic crisis. The prices of these fuels then declined significantly before a recent recovery (e.g., in July 2008 Henry Hub natural gas spot prices exceeded $13/MMBtu before dropping to a low of $1.82 on April 20, 2012 and recovering to $4.23/MMBtu on April 15, 2013). This price volatility and uncertainty as to future price levels increases the attractiveness of a generation resource that is not

[12] The surrounding states include Illinois, Kansas (due to proximity), Minnesota, Missouri, Nebraska, South Dakota and Wisconsin.

fuel-price dependent. Coal fuels about 45% of the generating nameplate capacity in the upper Midwest.[13] Natural gas-fired generation comprises another 29%. Non-hydro renewable generation (nameplate) and hydroelectric generation (nameplate) comprise 9.1% and 2.8%, respectively, of the total capacity within the upper Midwest.

According to the American Wind Energy Association, 1,084 MW of additional wind power was placed in-service in 2013 in the United States bringing the total wind development to over 61,108 MW. The state of Iowa with 5,177 MW is currently third behind only Texas (12,354 MW) and California (5,829 MW) in the amount of nameplate wind capacity installed as of the first quarter of 2014.

9. RESOURCE AVAILABILITY/STABILITY

Q. Please address the resource availability/stability criterion.

A. The resource availability/stability criterion was added to evaluate the less quantifiable aspects of the various fuels, their long-term supply (availability and access) and price stability. Other criteria touch on resource availability and stability, however, this criterion addresses both local and global access to a particular resource and its price stability over time. North America is no longer “resource independent” from other global influences. Activities around the globe can and do impact the prices of resources in North America. Some fuels (e.g., oil) are impacted to a greater degree than others, but over the expected life of the new resource installations, it is likely that other fuels could be impacted to greater or lesser degrees.

[13] The upper Midwest includes Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin.

Natural gas is currently abundant both within the U.S. and abroad; however, its price has demonstrated significant volatility historically, and there are potential infrastructure challenges to more abundant supply as natural gas use in power plants increases. Coal is also abundant in North America, but is currently hampered by emissions. Wind is also abundant in the U.S., especially the Midwest, and it is available at no cost; however, wind is intermittent. Overall, wind has an edge on both coal and natural gas.

E. SUMMARY OF NINE-FACTOR ANALYSIS

Q. Please summarize how wind compares to the other technologies.

A. As was true in prior wind ratemaking principle proceedings, Wind IX can be added to MidAmerican's generation portfolio at a reasonable price and it enhances environmental compliance, is projected to result in no net cost to customers, promotes economic development, supports Iowa's energy policy, improves fuel diversity and contributes toward energy and capacity needs. Wind IX clearly addresses multiple customer needs. Furthermore, wind ranks among the top generation technologies for five other criteria: cost robustness, environmental reasonableness, economic development, geo-political uncertainty, and diversity.

With respect to resource availability/stability, wind is not subject to fuel price volatilities like natural gas. Wind is abundant in Iowa, the seventh windiest state in the nation. However, the intermittency of the wind along with its impact on market prices due to transmission constraints keeps it from a top ranking in resource availability/stability. As for flexibility, wind generation is limited to operating only when sufficient wind is present. Wind turbines are not adaptable to other fuels or conversion to other technologies. Wind also rates less well with regards to system reliability when compared to the other technologies.

F. WIND VS. CONVENTIONAL GENERATION'S OPERATING CHARACTERISTICS

Q. Please discuss the operating characteristics of wind generation and conventional generation.

A. As was true in prior wind ratemaking principle proceedings, wind generation is more energy-focused with a limited contribution to meeting system peak capacity requirements. Wind generation in the Midwest is expected to have capacity factors in the 30 to 45% range. While wind generation's upfront capital costs lie between those of intermediate generation, such as combined-cycle combustion turbines, and baseload generation, such as coal, wind's operating costs are minimal. On the other end of the spectrum, conventional gas-fired combustion turbines address peak period requirements, but experience minimal operation during other periods of the year. Gas-fired facilities generally are characterized by lower upfront capital costs compared to other forms of generation, but gas-fired facilities have significantly higher operating costs. Typical capacity factors for peaking units in the Midwest are less than 5%.

Combined-cycle (gas-fired) plants typically operate at an intermediate level due to their low heat rate. Current operating levels vary widely across the U.S., from less than a 10% capacity factor to above 60%. Midwest units are typically in the 10% to 30% range. The upfront capital costs are higher than a simple-cycle combustion turbine, yet lower than conventional coal-fired generation. The combined-cycle units also have a heat rate advantage over both the simple-cycle units and coal-fired units. The relative price of natural gas to coal has recently resulted in efficient gas-fired combined-cycle combustion turbines being competitive with lower efficiency coal-fired units.[14]

Coal-fired units have a higher initial capital cost than most other conventional units with the exception of nuclear plants. Therefore, to be economical these units must operate at a relatively higher capacity factor, typically greater than 60%. Carbon regulation could add an additional capital cost and operating cost burden to coal-fired plants either through a carbon pricing mechanism or carbon capture and sequestration equipment. Such equipment may not be widely commercially available at a reasonable cost within the next decade.

Wind generation operates quite differently from conventional generation in that wind is intermittent. Wind generation is only available when sufficient wind is present—i.e., from approximately nine miles per hour to 50 miles per hour. On the other hand, conventional generation is dispatched as needed. A second difference is that wind generation is primarily an energy resource and does not contribute significantly to capacity supply during peak conditions, hence, wind generation is not meant to be an alternative to peaking generation. Even gas-fired combined-cycle generation that operates as an intermediate load plant is not comparable to wind since its primary period of operation is currently during the summer. Peaking and gas-fired intermediate generation complement, but do not normally compete with wind generation. Wind generation produces a significant amount of low cost, emission-free energy, and hence, offsets reliance on baseload generation, in particular coal-fired generation, thus reducing the rate of emissions.

[14] The dispatch cost advantage of coal-fired generation over that of gas-fired combined-cycle plants could be eroded by high carbon costs. Depending on the magnitude of carbon costs, efficient combined-cycle units might have a lower dispatch cost than moderately efficient coal-fired plants.

MidAmerican witness Jennifer McIvor testifies in this regard. The reduction in emissions is not limited to just MidAmerican's fossil units, but has a broader societal impact reducing output from the more costly, poorer efficiency units in the region first.

Q. How have you addressed the impact associated with incorporating Wind IX into the MidAmerican system?

A. MidAmerican has addressed the costs associated with incorporation of Wind IX by recognizing a differential in energy market prices across its service area due to the further addition of wind resources. MISO's large balancing area reduces the impacts of wind volatility in part due to wind diversity across the region and in part due to the larger number of resources available for balancing the load.

To address the intermittency of the wind resource the MISO developed a Dispatchable Intermittent Resource ("DIR") methodology that allows intermittent resources such as wind to be managed so that regional system requirements can be optimized (i.e., wind generation can respond to price signals, and as appropriate, reduce output or shut down). An offer is submitted to MISO so that the unit(s) may be dispatched economically as the intermittent resource permits.

G. FEASIBLE RENEWABLE GENERATION OPTIONS

Q. What constitutes renewable generation?

A. As was true in prior wind ratemaking principle proceedings, renewable generation utilizes natural resources that replenish over time, and therefore have long-term sustainability. Iowa law defines renewable generation, or an "alternate energy production facility," as follows: (a) a solar, wind turbine, waste management, resource recovery, refuse-derived fuel, agricultural crops or residues, or wood burning facility; (b) land, systems, buildings, or improvements that are located at the project site and are necessary or convenient to the construction, completion, or operation of the facility; and (c) transmission or distribution facilities necessary to conduct the energy produced by the facility to users located at or near the project site. A facility which is a qualifying facility under 18 C.F.R. part 292, subpart B is not precluded from being an alternate energy production facility under Iowa law.

The Energy Information Administration ("EIA") defines renewable energy resources as "Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration, but limited in the amount of energy that is available per unit of time. Renewable energy resources include: biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action."

Q. Describe each major type of renewable energy.

A. Renewable energy is generally categorized into five main classes: biomass, hydroelectric generation, wind, solar and geothermal. EIA further includes ocean thermal, wave action and tidal action, all of which are impractical for Iowa and will not be addressed.

1 - Biomass: Biomass represents an entire category of energy sources that use organic material of recent biological origin, including crops, wood, animal by-products, residues and wastes.[15] Biomass can be classified as cellulosic biomass (wood residues, forest materials), abandoned cropland (switchgrass, poplar and willow), anaerobic digestion (wastewater treatment, animal waste and animal bi-products) and landfill gas.

[15] The biomass definition is from the Iowa Department of Natural Resources' "2002 Renewable Energy Resource Guide."

2 - Hydroelectric generation: Hydroelectric generation is the capture of energy from moving water. Hydroelectric generation takes the form of pondage, run-of-river or pumped hydro.

3 - Wind: Wind energy is captured through the use of wind turbines of various sizes and designs, and then is converted to electricity.

4 - Solar: Solar represents the capture of the sun's energy by photovoltaic systems, central station solar-thermal applications (solar parabolic trough, solar power tower and solar-dish engine), or direct solar gain to produce electricity or generate heat.

5 - Geothermal: Ground source heat pumps that use the earth's more constant temperature near the surface for heating and cooling in buildings is the only practical geothermal application in Iowa. Other geothermal applications can be either naturally occurring (conventional geothermal) or man-made (enhanced geothermal systems[16]) where geothermal energy is energy extracted from the earth. While a region in eastern Iowa has been identified as a potential conventional geothermal resource for generation, development of that resource is not currently considered practical.

H. SELECTION OF WIND GENERATION

Q. Please explain MidAmerican's decision to develop additional wind-based generation rather than build another form of renewable generation.

A. Wind generation continues to be the most reasonable renewable resource available in sufficient quantity to provide a large contribution toward energy production in Iowa and to offset a portion of MidAmerican's carbon emissions.

[16] Additional enhanced geothermal systems information can be found at http://www1.eere.energy.gov/geothermal/pdfs/egs_basics.pdf

While biomass is plentiful (corn stover and switchgrass) in Iowa, there are several issues that need further vetting before relying on biomass as a major fuel source for renewable generation in Iowa. Issues with biomass include plant modifications for co-firing, operational issues associated with co-firing, storage, the amount of biomass that can be removed from the land without leading to erosion, reduction in soil nutrients and soil hydration, cost of the delivered fuel and competing uses such as ethanol production. While MidAmerican will continue to monitor the development of biomass, further research is required to better understand the longer-term economics and risks associated with biomass. Photovoltaic solar has made strides at reducing costs and is becoming more attractive in many states, but is not yet competitive with wind in Iowa. Other forms of renewable energy currently are simply impractical (geothermal) or are available in quantities too small to be a viable alternative (landfill gas, anaerobic digestion).

Q. What criteria did you use to compare the renewable resource options?

A. As has been the case in prior wind ratemaking principles proceedings, MidAmerican's focus on wind-powered generation as the most viable option for increasing its renewable generation portfolio is supported by consideration of the following criteria.

Availability

While Iowa has a number of renewable alternatives, few of those alternatives can be economically developed to a degree that will make a material contribution toward MidAmerican's energy needs, or a large contribution toward increasing renewable generation capacity in Iowa.

Economics

While the costs of renewable resources have been generally declining, other options currently remain too expensive to be practical as a large-scale supply resource to be included in a utility's resource mix.

Maturity

A technology achieves maturity as its development moves from the research phase to a wider acceptance, and a competitive industry develops for supply of the equipment related to that technology. Wind power has overcome many of its early technological obstacles and is now widely accepted. The cost of developing wind power projects is competitive with other sources of energy when adequate PTCs, and other revenue streams, are considered.

Q. Please discuss the availability of the renewable resources in Iowa.

A. Since renewable resource generation availability is tied to factors such as solar intensity, geothermal characteristics, agriculture production, and waterfall characteristics, the availability of renewable generation alternatives has not changed in any significant way in recent years. Table 3 summarizes the potential and feasible renewable resource capabilities available for development in Iowa. Competing uses for resources like biomass can significantly impact the availability of that resource for generation. This is especially true for cellulosic biomass where the current focus has turned to ethanol production, hence, limiting generation development from those materials in Iowa.

Table 3

Iowa - Potential for Renewable Generation Development [1]		
Technology/Resource	**Potential (GW)**	**Potential (GWh)**
Wind	571	1,723,588
On-shore	571	1,723,588
Off-Shore	n/a	n/a
Solar	4,044	7,029,897
Urban Utility Scale	16	27,092
Rural Utility Scale	4,021	6,994,159
Rooftop	7	8,646
BioPower [2]	4	28,928
HydroPower	<1	2,818
Geothermal	77	606,390
Conventional	<1	<1
Enhanced	77	606,390

Source: Lopez et al, National Renewable Energy Laboratory, U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis, (2012): http://www.nrel.gov/docs/fy12osti/51946.pdf

[1] Non-excluded land was assumed to be available to support development of more than one technology

[2] All biomass feed stock resources considered were assumed to be available for biopower use: competing uses such as biofuels production were not considered

Other Considerations: The data in Table 3 are from an NREL model and are estimates of technical, rather than economic or market, potential, NREL notes that these values do not consider:

• Allocation of available land among technologies (available land is generally assumed to be available to support development of more than one technology and each set of exclusions was applied independently)

• Availability of existing or planned transmission infrastructure that is necessary to tie generation into the electricity grid

• The relative reliability or time-of-productions of power

• The cost associated with developing power at any location

• Presence of local, state, regional or national policies, either existing or potential, that could encourage renewable development

• The location or magnitude of current and potential electricity loads.

The greatest potential for development of renewable resources in Iowa lies with wind. Iowa is the seventh windiest state in the nation based on wind energy potential according to the National Energy Renewable Laboratory,[17] and Iowa is currently a leader in wind development with the third most wind generation in operation of any state in the nation.

[17] Source: National Energy Renewable Laboratory's "Estimates of Windy Land Area and Wind Energy Potential by State for Areas >= 30% Capacity Factor at 80 Meters," dated February 4, 2010 and updated April 13, 2011 to add Alaska and Hawaii.

While over 4 GW of biopower potential has been identified, only a small portion will likely be available for generation. MidAmerican currently has 7.7 MW of biogas generation (mostly landfill and sanitation) in its portfolio. With presently available feedstocks, biomass generation will compete against other uses of biomass, especially ethanol production. At this time, landfills and farm-based methane present the most likely sources for biomass generation. Only 11 landfills with a capacity development potential of about 15 MW have been identified in Iowa.[18] Farm-based methane largely relies on anaerobic digestion as a source of generating methane gas for microturbine generators or small internal combustion engines (approximately 0.1 MW – 1.0 MW). A herd of 500 cattle is required to produce about 65 kW of electricity, so only larger farming operations are feasible sources of this type of generating capacity.

Iowa currently has 134 MW of hydroelectric, of which 125 MW is located at the lock and dam at Keokuk. The National Renewable Energy Laboratory estimates less than 1 GW of potential hydroelectric generation in Iowa Potential sites are distributed across Iowa. Environmental hurdles and high costs associated with hydroelectric development will likely continue to limit development.

Photovoltaic generation is the most likely solar technology to develop in Iowa and the most available per Table 3. Table 3 indicates solar technology as having over 4000 GW of potential in Iowa, mostly as utility scale resources in rural settings. Large photovoltaic or other solar technologies such as the parabolic trough, power tower and solar dish engine with substantial land requirements are better suited for lands elsewhere in the U.S. that are not as valuable for crop

[18] Black and Veatch estimated that only 6 of the landfill operations could be developed for electric generation with only 12 MW of potential, in the Renewable Energy Cost Effective Potential Study.

production. Other regions such as the Southwest have a key advantage: better solar insolation.[19] Iowa's solar insolation is only about 70% of that in California.

Over 7 GW of photovoltaic rooftop generation technical potential is estimated in Iowa.[20] However, the current cost of photovoltaic generation, compared to the amount of generation it produces, on a limited-time basis (day time only), limits its development.

Eastern Iowa has a limited potential for conventional geothermal generation, but the resource is lower temperature than in the regions where geothermal has been developed. Development of conventional geothermal generation in Iowa is not currently practical. Far superior geothermal resources located in the Western U.S. are only marginally economic to develop. Iowa has a much poorer resource (between 150 degrees and 200 degrees Centigrade) at a greater depth (about 6 kilometers or about 3.7 miles) that would be costly to access, even if it was technologically possible today. Costs for enhanced geothermal systems are generally higher than those for conventional geothermal plants and other more mature renewable technologies like wind power.[21]

Q. Provide a comparison of the cost of each of the renewable technologies.

A. The cost comparison (Table 4) for developing renewable technologies is based on estimates developed by Black and Veatch for the "Renewable Energy Cost Effective Potential Study" prepared for the Iowa Utilities Association.[22] However, hydroelectric was not included in the analysis, so the cost of this technology was

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[19] Solar insolation is the amount of solar energy received on a given area over time typically measured in kilowatt-hours per square meter.

[20] Source: National Renewable Energy Laboratory's "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis", July 2012, Table 4 – Total Estimated Technical Potential for Rooftop Photovoltaics by State.

[21] http://www.eia.gov/todayinenergy/detail.cfm?id=3970

[22] The requirements for "Renewable Energy Cost Effective Potential Study" were contained in legislation (SF 2386) approved by the 2008 Iowa Legislature and signed into law by Governor Chet Culver on May 6, 2008.

estimated from an alternative source. The U.S. Department of the Interior, Bureau of Reclamation conducted a hydropower resource assessment wherein cost of installed hydroelectric generation was estimated at an average of about $4,000/kW for units in the Great Plains Region.[23]

Table 4

Table 4-12. Renewable Technologies Performance and Cost Summary.

	Net Plant Capacity, MW	Net Plant Heat Rate, Btu/kWh	Capacity Factor	Capital Cost, $/kW	Fixed O&M, $/kW-yr	Variable O&M, $/MWh	Fuel Cost, $/MMBtu	Levelized Cost, $/MWh
Direct Biomass	35	13,500-17,500	80-90	4,500-5,500	85-110	11-15	0-8	65-210
Cofired Biomass	35	0.5-1.5 percent increase	unchanged	400-1,250	15-65	Incl. w/fixed	0-8	0-110
Landfill Gas	1-10	13,000	85	1,200-2,000	0	17	0.3-2	90-320
Anaerobic Digestion	0.15-6	12,000-13,000	80-90	8,000-16,000	800-1,300	Incl. w/fixed	N/A	350-700
Solar PV	20	N/A	15-20*	6,500-7,500	44	Incl. w/fixed	N/A	200-500+
Wind	150	N/A	25-40	2,100-2,600	50	Incl. w/fixed	N/A	60-130

*Capacity factor range for Iowa

Source: "Renewable Energy Cost Effective Potential Study" developed for the Iowa Utilities Association, dated December 1, 2008

Q. Please summarize the renewable generation options using the three criteria stated previously in your testimony.

A. My summary of the renewable alternatives for Iowa in terms of the three criteria (availability, economics and maturity) is shown in Table 5. The rating is from one (lowest or least desirable) to three (highest or most desirable) stars.

Table 5

Summary of Renewable Generation Selection				
	Availability	Economics	Maturity	Overall
Wind	★★★	★★★	★★★	★★★
Biomass – Cellulosic	★★	★★	★	★★
Biomass – Landfill	★	★★★	★★★	★★
Biomass – Anaerobic Digestion	★	★	★★	★
Hydro – Conventional	★★	★	★★★	★★
Hydro – Unconventional	★	★	★	★
Solar – Photovoltaic	★★	★★	★★	★★
Solar - Central Station	★	★	★	★
Geothermal	Not Practical in Iowa			

[23] Source: The U.S. Department of the Interior, Bureau of Reclamation's report, "Hydropower Resource Assessment at Existing Reclamation Facilities," March 2011.

While little solar power exists in Iowa currently, a number of states in the Midwest and east have solar requirements and solar is emerging from the early development stages as a source for generating electricity. However, in addition to its relatively high cost, solar is not as well-suited to Iowa as it is to other regions with higher solar intensity and less cloud cover. The photovoltaic technology (a two star overall rating) is likely to see some small, limited, site or customer-specific applications in Iowa (e.g., at the Iowa State Fairgrounds), but it is not considered capable of making a material contribution to Iowa's energy needs in the near term. Central station solar (parabolic trough, solar power tower, and solar-dish engine) will need to develop in regions with superior solar conditions first, and thus it is not expected in Iowa for the foreseeable future. The single star overall rating for central station solar reflects the current developmental potential of this renewable resource in Iowa.

Biomass is available in many forms some of which are well developed (e.g., landfill gas). However, landfill gas is available at a limited number of sites, and other forms of biomass are still in the early stages of development (e.g., anaerobic digestion), and are small and more costly. Use of generation resources such as landfill gas, sewage treatment gas or anaerobic digestion provide both electric generation and greenhouse gas destruction benefits.[24] These environmental benefits coupled with the electrical production may provide cost-effective generation resources on a limited scale. The double star overall rating for landfill and cellulosic biomass represents the potential for some limited forms

[24] The methane global warming potential is 23 times greater than that for carbon dioxide based on the International Panel on Climate Change ("IPCC") Third Assessment Report. The greenhouse gas destruction benefits relate to the burning of methane, which releases carbon dioxide, yet reduces the global warming impact by a factor of 22.

of biomass to be researched and developed in Iowa, but not on the level or at a cost MidAmerican finds currently desirable. The single star for anaerobic digestion biomass generation reflects the limited experience in this biomass technology.

Hydroelectric, the most mature of any renewable generation, is perhaps the closest viable alternative to wind in that a number of potential sites along rivers and lakes exist, but its costs, environmental and political issues have limited its development. The double star overall rating for conventional hydropower reflects the potential for development while recognizing the obstacles that new hydroelectric generation developments face. Unconventional hydropower development was awarded a single star due to its more limited availability, newer technology and cost.

No geothermal sites are considered practical in Iowa for the generation of electricity; thus, no ranking is possible. Even development of geothermal power in the Western U.S., where far superior (closer to the surface and higher temperature) geothermal resources exist, has been limited due to cost. Accessing Iowa’s lower temperature resource at a much greater depth (6 kilometers) provides both technological and economic challenges that are difficult to quantify with the little information that is currently available.

Wind power, the most abundant renewable resource in Iowa, is a cost-competitive source of energy (when the PTC, and other revenue streams, are included) that has achieved a reasonable level of technological maturity. Thus, wind power receives the highest relative rating of the renewable resources reviewed.

Q. Please summarize the selection of wind as the preferred renewable generation option.

A. While MidAmerican supports research in Iowa into new renewable technologies (e.g., PV solar at the Iowa State Fair), the Company believes its large generation additions should be based on functioning technologies that are relatively mature. Wind-based generation is the only renewable resource in Iowa that is mature, economically viable, and in sufficient supply to satisfy MidAmerican's needs. Improvements to the technology over the past two decades have made it one of the leading renewable resources.

I. FUTURE CAPACITY REQUIREMENTS

Q. In prior wind ratemaking principle applications, MidAmerican identified and quantified a capacity value for the proposed wind projects. How is MidAmerican looking at the potential capacity benefit of Wind IX?

A. While MidAmerican's existing wind generation projects (Wind I – VIII) have proven to provide capacity benefits in the form of accredited capacity, MidAmerican is not including a quantified capacity benefit in its overall assessment of Wind IX benefits.

Q. Why is there no quantified capacity benefit for Wind IX?

A. MidAmerican believes it would be better to await completion of the MISO interconnection studies of Wind IX sites before attempting to quantify any capacity benefit. These studies will determine the extent of transmission construction that will be required to enable capacity resource eligibility.

Q. You have used the term "no quantified" preceding the words "capacity benefit." Why?

A. While, for the reasons explained in the preceding answer, MidAmerican has not quantified the capacity benefit of Wind IX, based upon past experience with wind generation and the MISO capacity accreditation process it is likely that Wind IX will provide some capacity benefit. However, the incremental amount of wind generation is relatively small compared to MidAmerican's existing wind generation portfolio. Further, as MidAmerican has addressed in the past, wind generation accreditation levels are substantially lower than the nameplate capacity. Although Mr. Yocum's analysis does not ascribe a dollar value to Wind IX capacity, having Wind IX as part of MidAmerican's generation portfolio is likely to prove somewhat beneficial to our customers in the future, from a capacity perspective.

Q. Please discuss capacity versus energy as it pertains to Wind IX.

A. First, I think it is worth re-emphasizing that wind generation is primarily about energy production, and related benefits, and as a rule does not contribute a great deal toward capacity requirements. While Wind IX may contribute to future capacity needs, like all wind generation it is primarily an energy-related resource, which can offset fossil fuel energy generation, and hence, emissions related to fossil fuels such as carbon, mercury, sulfur oxides, oxides of nitrogen and other potential emissions. Based on MISO's latest calculation of the system-wide average contribution of wind resources to meeting peak load, Wind IX could contribute as much as 14.1% of its nameplate capacity toward MidAmerican's resource adequacy obligation planning reserve margin (i.e., approximately 22 MW).[25]

Q. What is MidAmerican's available generating capacity?

A. Based upon performance test data for MISO, MidAmerican owns 5,420.3 MW of capacity applicable to the June 2014 - May 2015 planning year as shown in Table 6. Upcoming compliance requirements under the Mercury and Air Toxics Standards ("MATS") will change this table. The MATS rule requires that all coal-fueled units either install emission controls or retire. Accordingly, by April 2016, the Riverside Unit 5 coal plant will be utilized only as a natural gas resource and Walter Scott Jr. Energy Center Units 1 and 2 and George Neal North Units 1 and 2 will be retired. All other units are or will be equipped with controls to meet the MATS requirements.

[25] The 14.1% capacity credit for Wind IX is based on MISO's system wide average value reported in the report "MISO Planning Year 2014-2015 Wind Capacity Credit," dated December 2013, https://www.misoenergy.org/Library/Repository/Study/LOLE/2014%20Wind%20Capacity%20Report.pdf.

Table 6

	Unit Name	Unit Type	Fuel Type	Nameplate Capacity (MW)		MISO Accredited Installed Capacity MW (1)	Total Installed Capacity MW by Type
MidAmerican Energy Company's Existing Owned Generation							
MISO Planning Year 2014-15							
Peaking Units							
	Coralville (4 Units)	Combustion Turbine	Natural Gas	72.0		64.5	
	Electricfarm (3 units)	Combustion Turbine	Natural Gas/ Fuel Oil #2	264.1		188.1	
	Greater Des Moines	Combustion Turbine	Natural Gas	576.3		485.2	
	Knoxville Industrial (8 Units)	Internal Combustion	Fuel Oil #2	16.0		16	
	Merle Parr (2 Units)	Combustion Turbine	Natural Gas	36.0		34.4	
	Moline (4 Units)	Combustion Turbine	Natural Gas	72.0		64	
	Pleasant Hill (3 Units)	Combustion Turbine	Natural Gas/ Fuel Oil #2	179.9		161.2	
	River Hills (8 Units)	Combustion Turbine	Natural Gas	128.0		121.8	
	Shenandoah (10 Units)	Internal Combustion	Fuel Oil #2	20.0		20	
	Sycamore (2 Units)	Combustion Turbine	Natural Gas/ Fuel Oil #2	157.5		147.9	
	Waterloo Lundquist (9 Units)	Internal Combustion	Fuel Oil #2	18.0		18	
	Anderson Erickson	Internal Combustion	Fuel Oil #2	2.0		2	
Total Peaking					1,539.8		1,323.1
Hydro							
	Moline Hydro (4 Units)	Hydro	Water	3.6		0.5	
Total Hydro					3.6		0.5
Coal-fired Units							
	Walter Scott Jr. #1	Coal-fired	Coal - Sub-bituminous	49.0		39.4	
	Walter Scott Jr. #2	Coal-fired	Coal - Sub-bituminous	81.6		84.7	
	Walter Scott Jr. #3	Coal-fired	Coal - Sub-bituminous	574.1		514.4	
	Walter Scott Jr. #4	Coal-fired	Coal - Sub-bituminous	550.4		533	
	Louisa	Coal-fired	Coal - Sub-bituminous	714.5		658.8	
	Neal #1	Coal-fired	Coal - Sub-bituminous	147.1		135.3	
	Neal #2	Coal-fired	Coal - Sub-bituminous	349.2		259.2	
	Neal #3	Coal-fired	Coal - Sub-bituminous	395.9		365.5	
	Neal #4	Coal-fired	Coal - Sub-bituminous	259.6		261.7	
	Ottumwa	Coal-fired	Coal - Sub-bituminous	377.5		373.4	
	Riverside 5	Coal-fired	Coal - Sub-bituminous	136.0		124.2	
Total Coal-fired					3,634.9		3,349.6
Wind							
	Adair	Wind	Wind	174.8	x	24.8	
	Carroll	Wind	Wind	150.0	x	25.3	
	Century	Wind	Wind	200.0	x	24	
	Charles City	Wind	Wind	75.0	x	10	
	Eclipse	Wind	Wind	200.1	x	26.5	
	Intrepid (Clipper)	Wind	Wind	175.5	x	23.3	
	Laurel (2)	Wind	Wind	119.6	x	16.5	
	Morning Light	Wind	Wind	101.2	x	20	
	Pomeroy (Pocahontas)	Wind	Wind	286.4	x	38.3	
	Rolling Hills (3)	Wind	Wind	443.9	x	43.2	
	Victory	Wind	Wind	99.0	x	18.5	
	Vienna	Wind	Wind	150.2	x	0	
	Walnut	Wind	Wind	153.0	x	22.5	
	State Fair	Wind	Wind	0.5	x	0	
Total Wind					2,329.2		292.9
Nuclear							
	Quad Cities #1	Nuclear - Boiling Water	Uranium	252.3		228.1	
	Quad Cities #2	Nuclear - Boiling Water	Uranium	252.3		226.1	
Total Nuclear					504.6		454.2
Total Owned Capacity				8,014.1	8,012.1	5,420.3	5,420.3

(1) MISO 2014-15 Planning Year installed capacity ratings, except wind which is expressed as summer accredited capacity, and Charles City 2 which is estimated since it did not test for the 2014-15 Planning Year

(2) Laurel and Vienna are Energy Resource Interconnection Service status; hence are not listed as summer accredited capacity.

(3) Rolling Hills is currently output limited as per conditions in the provisional generator interconnetion agreement.

Q. Does MidAmerican currently own or purchase power from renewable generation facilities?

A. Yes. MidAmerican currently has 2,329.2 MW of owned wind generation in operation, including the following owned wind generation: 175.5 MW at its Intrepid site, 200.1 MW at its Century site, 99 MW at its Victory site, 286.4 MW at its Pomeroy site, 75 MW at its Charles City site, 174.8 MW at its Adair site, 150 MW at its Carroll site, 153 MW at its Walnut site, 443.9 MW at its Rolling Hills site, 119.6 MW at its Laurel site, 200.0 MW at its Eclipse site, 101.2 MW at its Morning Light site, 150.2 MW at its Vienna site and 0.5 MW at the Iowa State Fairgrounds. MidAmerican also purchases another 118.2 MW of renewable power, including: 108.75 MW of wind power and 7.68 MW of methane gas-fired generation from landfill operations. In addition, MidAmerican owns 3.6 MW of run-of-the-river hydroelectric generation in Illinois. Another 20 MW purchase of wind power will occur in late 2014 or early 2015. With the completion of Wind VIII projects, MidAmerican will have 3,477 MW of renewable capacity, in its portfolio as of the end of 2015, of which 3,339.4 MW will be owned by MidAmerican, and this is before adding the proposed Wind IX project.

Of possible interest is the fact that other Berkshire Hathaway Energy Company (formerly, MidAmerican Energy Holdings Company) subsidiaries currently have another 6,087 MW of owned and purchased renewable generation, worldwide, in the form of geothermal (773 MW), hydroelectric (1,816 MW), wind (2,433 MW), solar (955 MW), biomass (70 MW) and biogas (40 MW) in operation as of June 2014.

ANALYSIS IN SUPPORT OF MR. YOCUM'S FINANCIAL ANALYSIS

Q. What analysis has MidAmerican performed with respect to the impact of Wind IX on MidAmerican's customers?

A. MidAmerican evaluated the 162 MW Wind IX project to determine its cost impact on customers. This evaluation is explained in the testimony of MidAmerican witness Mark Yocum who conducted an economic analysis of Wind IX.

In support of the above-mentioned economic analysis by Mr. Yocum, MidAmerican's generation system was modeled on a long-term basis, both with and without Wind IX's 162 MW using a production cost model.[26] The production cost model results that I am supporting were provided to Mr. Yocum for use in his economic analysis. The production cost model dispatches MidAmerican's generation against an electric price forecast for MidAmerican. This model provides the level of operation, cost of fuel and other costs of operation, along with the total net system operating cost (i.e., fuel cost plus non-fuel variable costs plus wholesale purchases less wholesale sales). The projected output for the 162 MW of additional wind capacity may be found in the Ratemaking Principles Application, Section 2, Confidential Table 2.1-2. The tables have been electronically provided with this filing.

Q Mr. Yocum's economic analysis includes separate consideration of renewable energy credits and wind's zero emission characteristics with respect to future carbon regulation. Please explain these two factors.

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[26] MidAmerican uses Ventyx's PROMOD® program, a chronological dispatch model that simulates the operation of each plant based on detailed plant data, fuel and other operating cost data and market prices.

A. In prior ratemaking principle proceedings, MidAmerican sought and obtained ratemaking principles that would provide customer benefits for "Renewable Energy and CO_2 Credits and the Like." That ratemaking principle recognized that separate markets may develop for the various attributes of wind energy. MidAmerican has participated in the market for the sale of renewable energy credits, commonly referenced as REC's. Historically, a separate trading market for the carbon-free generation has existed in certain Northeast and Mid-Atlantic states known as the Regional Greenhouse Gas Initiative, or "RGGI." RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont, designed to cap and reduce power sector CO_2 emissions. In those states, there is trading of CO_2 credits where CO_2 credits are purchased and sold separate and independent of the REC sales market.

Subsequent to the EPA's issuance of the Clean Power Plan in June of this year (i.e., the proposed new EPA regulations discussed by MidAmerican witness McIvor), it makes sense to recognize that carbon-free benefits merit quantification. At present, there is no regulatory prescription for quantifying the value of such benefits, but RGGI has an established market and MidAmerican has used data from that market as a reasonable proxy for capturing the value of carbon free resources. As the compliance dates under the Clean Power Plan draw near, the RGGI prices or alternate forms of direct carbon regulation will likely change, increasing costs associated with emission compliance for utilities. Thus, MidAmerican believes that using RGGI pricing is a conservative, proxy measure of the value of carbon-free generation.

Q. The economic analysis completed by Mr. Yocum in support of the 162 MW Wind IX project includes a benefit to Wind IX arising from future carbon regulations. Please describe this benefit.

A. As I just noted, the EPA's proposed rulemaking for Section 111(d) would include new restrictions on the production of electricity from fossil-fueled generation to meet the carbon output reduction limits. These restrictions will enhance the economics of zero emission resources such as wind generation. MidAmerican's economic analysis of Wind IX includes a quantification of Wind IX benefits related to these proposed new greenhouse gas emissions rules. RGGI is used as the vehicle to quantify the value of wind generation's carbon-free benefits.

Q. Please describe MidAmerican's quantification of the market price impact of future greenhouse gas emissions rules.

A. The RGGI has created a market for the sale and purchase of CO_2 emission credits. There is not currently any such market for utilities operating within MISO, so MidAmerican utilized RGGI market data from the RGGI auction process and then used market models to forecast the impact to Midwest electricity prices for associated comparable emission restrictions.

Specifically,____

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____. The resulting benefit is the value of Wind IX as a zero emission resource to avoid the dispatch and CO_2 emission costs from carbon-emitting generation sources (e.g., coal, gas).

Q. Is the greenhouse gas emissions benefit assigned to Wind IX reasonable?

A. Yes. As Ms. McIvor has observed in her testimony, the final content of the future regulations limiting greenhouse gas emissions is not yet known. Nevertheless, it is reasonable to conclude that new restrictions on the production of electricity from fossil-fueled generation to meet the carbon output reduction limits will enhance the economics of zero emission resources such as Wind IX, and what was developed is a conservative estimate. The method we've utilized relies upon market price data from an existing emissions allowance program. Until such time as more information is known about state implementation plans, the benefits identified by our analysis provides a reasonable value for the avoided CO_2 emissions of Wind IX.

Q. The economic analysis completed by Mr. Yocum regarding the 162 MW Wind IX project also includes a benefit to Wind IX for renewable energy credits. Please describe this benefit.

A. It is also appropriate to capture the value of renewable energy credits (RECs) for Wind IX. RECs allow a buyer to make specific environmental claims about how their specific electricity is produced from renewable resources while ensuring this value is not double-counted. The Wind IX REC benefit assigns a value to the property right attribute only, separate from the value of the avoided dispatch cost related to the EPA's proposed new greenhouse gas regulations described above. New, or changes to, state renewable portfolio standards, national energy policy, environmental policies and assumptions, or renewable energy credit market requirements are all examples of conditions that could alter the decision to sell renewable energy credits, and the market value of the RECs. The REC value included with the Wind IX assessment is based upon current market prices and represents the avoided cost of acquiring RECs from other market participants, or in the case of a REC sale, the value of the sale.

Q. At what price are renewable energy credits trading?

A. During August 2014, the national voluntary wind renewable energy credit market 2014 price was $1.08/MWh for the second half of 2014, as reported in *Argus Daily*.

Q. Is the renewable energy credit benefit assigned to Wind IX reasonable?

A. Yes.

Q. Does this conclude your testimony?

A. Yes.

STATE OF IOWA)
) ss:
COUNTY OF POLK)

I, Neil D. Hammer, being first duly sworn, depose and state that the statements contained in the foregoing prepared direct testimony are true and correct to the best of my knowledge, information and belief, and that such prepared direct testimony constitutes my sworn statement in this proceeding.

/s/ Neil D. Hammer__________
Neil D. Hammer

Subscribed and sworn to before me this 9th day of October, 2014.

/s/ Sherri R. Long___________________
Notary Public – Iowa