Environmental Impacts of Montana's Renewable Portfolio Standard

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Quantifying the environmental impacts of renewable energy requirements in Montana must be examined in terms of short-term and long-term impacts, perspectives, and goals. The Renewable Power Production and Rural Economic Development Act, often referred to as Montana's Renewable Portfolio Standard (RPS), requires public utilities to obtain a percentage of their retail customer sales from renewable resources. Starting in 2008, public utilities were required to acquire renewable energy equal to 5% of its retail sales of electricity in Montana. That percentage will be bumped up to 10% in 2010 and 15% beginning in 2015.

Senate Joint Resolution No. 6 sets out the parameters that the Energy and Telecommunications Interim Committee (ETIC) is to analyze in its review of the environmental impacts of the RPS. Those parameters include the standard's contribution to:

- diversified generation in Montana and to reduced dependence on fossil fuels,
- the types of renewable energy generation used in meeting the standard, and
- potential contributions to air quality improvements attributable to the standard.

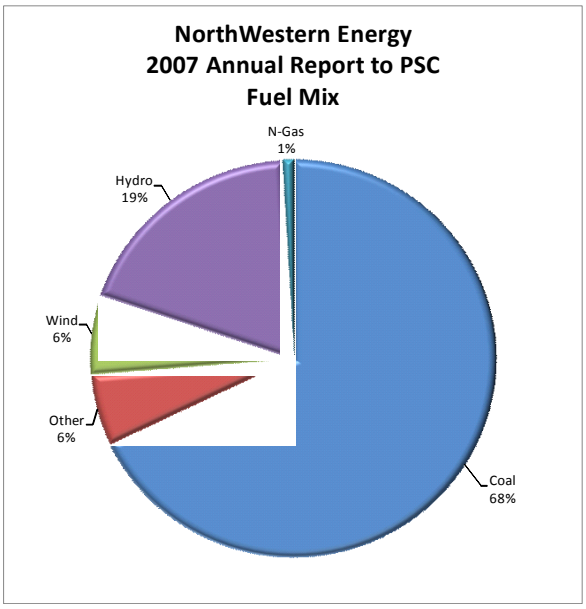
This report examines those three issues. Any widely installed technology can be accompanied by environmental challenges. Wind generation, as an example, brings additional environmental policy matters -- ranging from wildlife and habitat impacts to land use changes. Studies weigh the costs and benefits of state renewable portfolio standards, but beyond analysis of carbon reduction costs, attempts to quantify the environmental impacts of individual state requirements are limited. Environmental impacts can vary depending on the mix of renewable technologies used in meeting a standard, and the proportion of in-state versus out-of-state renewable generation used. This report attempts to identify Montana-specific environmental impacts.

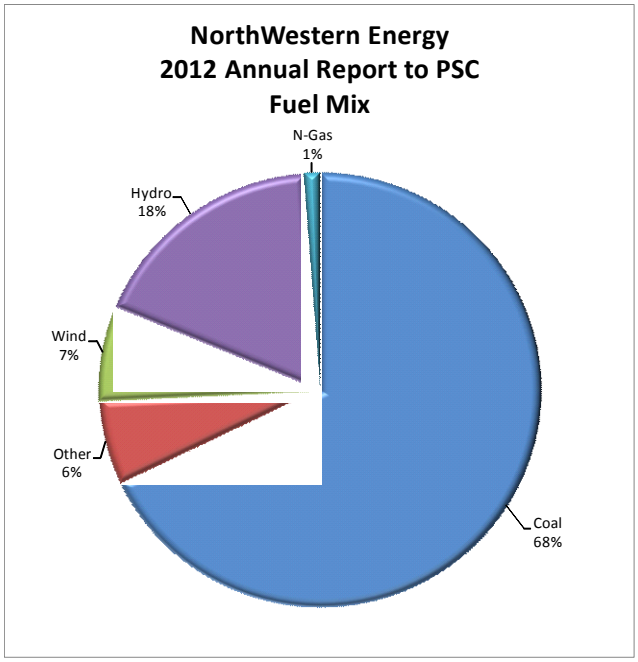
Renewable generation in Montana has increased since the passage of Montana's RPS. There are currently 542 megawatts of renewable energy generation certified by the Montana Public Service Commission (PSC) as renewable energy used to meet Montana's RPS. Of that total, about 250 megawatts of that renewable generation are located in Montana. The remainder delivers electricity into Montana from another state. For the purposes of this report, no assumptions are made as to why a renewable resource was constructed -- to meet the Montana RPS or not.[1] It is

[1]The 135-megawatt Judith Gap Wind Farm was constructed prior to enactment of Montana's RPS requirements. There has been much discussion as to the role Montana's RPS contributed to its completion and the long-term contract entered into with NorthWestern Energy.

also important to note that the two largest utilities required to meet the Montana RPS are different utilities in terms of regulation and sales in Montana. NorthWestern Energy serves about 342,000 electric customers in Montana. Montana-Dakota Utilities Co. (MDU) provides electricity supply to about 24,320 customers in Montana. MDU emphasizes that its generation serves a three-state service territory and generally credits about 25% of the capacity at its wind farms to Montana. In this report, total nameplate capacity from eligible renewable resources, certified by the PSC as being used to meet the RPS, are included in most calculations.[2]

Charts 1 and 2





Findings

- While renewable generation increased since the passage of Montana's RPS, the portfolio's of Montana's two largest regulated utilities do not demonstrate a decrease in commitment to fossil-fuel generation. In some instances the impact of renewable generation on fossil-fuel generation is examined in terms of generation that is displaced. In general, electricity produced by a renewable resource, such as wind, is matched by an equivalent decrease in electricity generation at another resource -- simply because a utility must balance supply with demand at all times. In most cases the generation that is displaced is that of a fossil-fuel plant because of higher fuel costs.

- In examining the portfolio's of Montana's two largest regulated utilities, it is difficult to capture the type of generation being displaced by renewable generation without an examination of a utility's unique situation, market purchases and how renewable resources are being used to meet increased load growth. For example, with oil and gas

[2]The term RPS includes Community Renewable Energy Project (CREP) requirements.

development, MDU has experienced robust load growth. NorthWestern Energy has only been able to own its own generation since 2007.

- A look at NorthWestern Energy's fuel mix overall in 2007 and in 2012 is demonstrated in **Chart 1 and Chart 2**[3]. Purchase power accounted for about 2.2 million megawatt hours in 2007. The fuel mix of that purchase power was about 65% coal and 35% hydroelectricity. In 2012 the fuel mix did not change and purchase power represented about 2 million megawatt hours. The portion of wind is shown increasing from 6% to 7%. (The utility is meeting the 10% RPS requirement with a mixture of wind, banked renewable energy credits, and small hydroelectric projects.) The charts exclude resources used for transmission and grid reliability -- also known as balancing resources. When balancing resources are included, the biggest change in NorthWestern Energy's fuel mix between 2007 and 2012 is an increase in natural gas due primarily to its expanded use as a balancing resource.

- Capturing air quality improvements specific to Montana brings up the same discussion as covered previously concerning the use of renewable generation to displace fossil-fuel based generation. Using a one-to-one ratio, the 542 megawatts of renewable energy certified for use in meeting Montana's RPS offset 542 megawatts of nonrenewable energy. For the two largest utilities in Montana, this is likely an offset of market purchases.

- Utilities indicate that natural gas-fired generation matches better with renewable generation, like wind, than with coal-fired power plants. Most coal plants run as a baseload resource -- essentially 24 hours a day -- because they can provide large quantities of predictable supply. "As a fast ramping resource that is relatively easily turned on and off, natural gas-fired power plants are well- suited for backing up and smoothing out intermittent renewables and providing capacity."[4] While renewable generation doesn't necessarily displace coal-fired generation in Montana, that pairing of natural gas and renewable energy, which is on the rise in Montana, provides for less of an overall carbon footprint than coal-fired generation.

- If the one-to-one ratio is taken in examining air emissions that are displaced and an assumption is made that the 542 megawatts of renewable generation certified by the PSC, operating with a 40% capacity factor, displace natural-gas generation in most instances, then about 1.1 million tons of carbon dioxide, 95 tons of sulfur dioxide, and 11,615 tons of nitrogen oxides are displaced by renewable generation. If that renewable energy was to

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[3] NorthWestern Energy. Data Source: 2007 and 2012 Schedule 34, NorthWestern Energy Annual Report to the PSC.

[4] http://www.texascleanenergy.org/Brattle%20report%20on%20renewable-gas%20FINAL%2011%20June%202013.pdf

displace coal-fired generation, then about 2.1 million tons of carbon dioxide, 13,300 tons of sulfur dioxide, and 5,700 tons of nitrogen oxides would be displaced.

Diversified generation and reduced dependence on fossil fuels

In the least complex view of long-term environmental impacts, renewable resources have less of an impact on the environment than nonrenewable resources, simply because they use a renewable fuel rather than fossil fuel.

> "The point of an RPS is to replace fossil fuel generation with generation obtained from renewable resources. Therefore, most straightforward measures of RPS effectiveness are the degree to which renewable energy capacity and generation have grown, and the degree to which fossil fuels have declined as a share of the state's electric-generation fuel mix."[5]

Table 1

Net Electric Generation by Type of Fuel Unit				
Year	Hydroelectric %	Coal %	Natural Gas/Petroleum %	Wind %
2005	34	64	1	0
2006	36	61	1	2
2007	33	64	2	2
2008[1]	34	62	1	2
2009	36	59	2	3
2010	32	63	1	3
2011	42	50	3	4

In Montana wind power generation grew by 34% in 2011 and supplied 4.2% of the state's net electricity generation.[6] All of the state's renewable energy growth, however, cannot be attributed solely to Montana's RPS. Of the 647 megawatts of wind generated in Montana (operational as of September 2013), about 400 megawatts, or 62%, was generated by the Rim Rock and Glacier wind farms in northern Montana. The renewable energy attributes of those wind farms are used to meet California's RPS not Montana's RPS. About 13 megawatts of wind generated in Montana are qualifying facilities (QFs) which in many cases are not used by utilities or suppliers to meet the Montana RPS. (This is decided in the contract agreed to by the generator and utility.) About 234 megawatts of wind, located in Montana, are certified to meet the Montana standard, or about 36% of the wind generation total.

In 2009, coal-fired generation made up about 59% of Montana's generation capacity. In 2011, coal-fired generation declined to about 50% of Montana's capacity. **Table 1** outlines generation in Montana by fuel type.[7] However, throughout this report it is important to note that Montana is

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[5]"State Clean Energy Practices: Renewable Portfolio Standards", David Hurlbut, July 2008, National Renewable Energy Laboratory, U.S. Department of Energy.

[6]http://www.eia.gov/state/?sid=MT

[71]Montana's RPS, as originally passed and approved, required public utilities starting in 2008, to acquire renewable energy equal to 5% of its retail sales of electricity in Montana.

a net exporter of electricity. In general, Montana usage and transmission losses account for slightly more than half of production.

In looking at the big picture, renewable energy generation in Montana has increased and fossil-fuel-based generation has declined. It is difficult to determine whether the increases and declines are related to changes in state and federal policy, to changes in energy markets and prices, or to new technology development. It is likely that the changes may be attributed to a combination to some degree to all factors. To make the numbers a bit more relevant to Montana's RPS the portfolios of Montana's two largest regulated electric utilities provide a better look at patterns in energy generation.

Every two years, NorthWestern Energy files an Electric Supply Resource Procurement Plan and Montana-Dakota Utilities files an Integrated Resource Plan with the Public Service Commission (PSC). The plans outline the actions a utility will take to meet its anticipated customer needs. The plans outline the needs of customers, the existing electricity supply resource portfolios of the utility, and options for the future -- including an evaluation of the costs and risks associated with various alternatives.

Because NorthWestern Energy has only been acquiring generation assets since 2007, its portfolio provides a mix of contract power and utility-owned generation. In 2007, NorthWestern Energy's Resource Procurement Plan included 325 megawatts of firm on-peak power and 175 megawatts of off-peak power from PPL Montana under a contract that will expire in June 2014. The contract provided about 37% of the total portfolio's energy requirements for 2007.

The plan also included 100 megawatts of QF energy, and of that QF total, hydroelectric supplied 13%, wind supplied 4%, and the remainder was fossil-fuel based. In 2006 NorthWestern began receiving power from Judith Gap, amounting to 135 megawatts of wind energy. The utility also had a 6 megawatt contract with Tiber Montana, a small hydroelectric facility. Finally, NorthWestern has a contract with Basin Creek Equity Partners for a 52-megawatt gas peaking facility. NorthWestern also entered into a contract with Montana Generation (Colstrip Unit 4) for the purchase of 90 megawatts of unit power.[8] (By the close of 2007, NorthWestern Energy had acquired an interest in 222 megawatts total in Colstrip 4.)

The 2007 report discusses overall renewable portfolio requirements. "In order to be in compliance with the Renewable Act through 2011, NorthWestern does not anticipate needing any additional renewable resource beyond the quantities necessary to meet the community

[8]NorthWestern Energy 2007 Electric Supply Resource Procurement Plan, December 2007, pages 19-25.

renewable energy project (CREP) standard."[9] Montana's RPS includes provisions for CREPs, defined as renewable energy projects under 25 megawatts where local owners have a controlling interest. For compliance years 2012 through 2014, utilities must purchase both the renewable energy credits (RECs) and the electricity output from CREPs totaling at least 50 MW in nameplate capacity. For compliance year 2015 and each following year, utilities must purchase both the RECs and the electricity output from CREPs totaling at least 75 MW in nameplate capacity. RECs are a tradable certificate of proof of 1 megawatt hour of electricity generated by an eligible renewable resource. The 2011 NorthWestern Energy Resource Procurement Plan also outlines a portfolio resource mix that includes coal, natural gas, hydroelectricity, wind, and qualifying facilities. **Table 2** provides a snapshot of the installed generating capacity. In general terms, the procurement plan shows 67% owned or contracted thermal and 33% contracted nonthermal for its total installed generating capacity.

Table 2

NorthWestern Electric Supply Resource Portfolio Installed Generating Capacity 2011	
Resource or Group	**MW**
Colstrip 4 - Coal	222
Basin Creek - natural gas	52
Dave Gates - natural gas	7
QF Tier II -- Thermal	87
Total Thermal	**368**
QF Tier II - Hydro/Wind	13
QF 1 Hydro/Wind	14
Judith Gap - Wind	135
Tiber/Turnbull - Hydro	19
Total Non-Thermal	**181**

NorthWestern Energy notes in the 2011 plan that the Dave Gates Generating Station at Mill Creek is a 150-megawatt natural gas-fired facility east of Anaconda. In the report, Dave Gates is included as a 7-megawatt base load resource because it contributes 7 megawatts toward meeting peak demands.

In addressing Montana's renewable portfolio standard, the 2011 report includes the addition of the 40 megawatt Spion Kop wind project and new qualifying facility projects totaling about 50 megawatts. "These new projects and existing eligible projects are forecast to supply energy and associated RECs to meet the Montana RPS for approximately the next five years, through the 2016 RPS compliance year."[10] NorthWestern Energy will file its 2013 plan with the PSC before the end of the year.

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[9]NorthWestern Energy 2007 Electric Supply Resource Procurement Plan, December 2007, page 33.

[10]NorthWestern Energy 2011 Electricity Supply Resource Procurement Plan, December 2011, page 74.

In comparing the 2007 and 2011 reports for NorthWestern Energy, the amount of renewable generation in the portfolio has increased and is expected to increase even more with the addition of Spion Kop. With acquisition of an increased interest in Colstrip and construction of the Dave Gates Generating Station at Mill Creek, the amount of fossil-fuel based generation has also increased in the NorthWestern portfolio.

When Montana-Dakota Utilities Co. filed its 2007 Integrated Resource Plan, the company was in the process of constructing the 20-megawatt Diamond Willow Wind Farm near Baker to meet the first two phases of the Montana RPS and announced plans to install an additional 10 megawatts to meet future requirements. The company provided **Table 3** as a representation of its expectations for 2012, based on the 2007 report.[11]

Table 3

MDU Expected Generation for 2012		
Generation	**Megawatts**	**Percentage**
Natural Gas/Oil Glendive 1 and 2 Miles City Williston	110.8 mW	17%
Wind Diamond Willow	20 mW	3%
Coal Heskett 1 and 2 Lewis and Clark Big Stone 1 and 2 Coyote	488.3 mW	77%

MDU recently filed its 2013 plan noting that it now has 50 megawatts of installed wind generation capacity at two locations, providing about 7% of its customers' electric energy requirements. (MDU is meeting the 10% RPS requirement in Montana, but is utilizing additional means to meet the standard.) The report concludes that the optimal resource mix includes the commercial operation of Heskett 3 (natural gas) by 2015, three additional 36.6 megawatt internal combustion engine projects, contracting for 50-to-100 megawatts of wind generation, and adding 200 megawatts of combined cycle unit in 2020.[12]

Similar to NorthWestern energy, the 2007 and 2013 MDU plans show an increase in renewable generation as a portion of the portfolio. The plans do not demonstrate a decrease in coal or natural gas generation. In the MDU plan there is a strong commitment to update fossil-fuel based generation and to keep it in the mix.

[11]MDU Integrated Resource Plan 2007, May 2007, executive summary, page iii.

[12]Ibid, page iv.

Types of generation used in meeting the standard

In a survey of generators, utilities, and suppliers, approved by the ETIC and sent out in mid-September, the committee asks those entities if specific facilities would have been built had there not been a renewable energy requirement in Montana. The responses provided will offer the committee additional insight into the types of renewable energy generation that was built as a result of Montana's RPS and the resulting changes in portfolios as discussed above.

Regardless of why a facility was built, however, the PSC has certified about 542 megawatts as eligible renewable resources, some of which are community renewable energy projects (CREPs) that can be used to meet Montana's RPS. Utilities and electricity suppliers petition the PSC for certification of eligible renewable resources to verify that the power produced at a facility meets Montana's definition of renewable.

Renewable "electricity", however, is not necessarily used to meet the overall standard. In order to meet the standard, a public utility or competitive electricity supplier may use electricity from an eligible renewable resource in which the associated RECs have not been sold separately, RECs created by an eligible renewable resource purchased separately from the associated electricity, or a combination of the two. In many cases, a utility or supplier is procuring RECs, not necessarily procuring energy itself.

In addition, of the total renewable generation, about 292 megawatts of renewable energy projects certified to meet the Montana standard are not located in Montana. A renewable resource can be used to meet Montana's standard if it delivers electricity from another state into Montana and commenced commercial operation after January 1, 2005. At various times since 2010, for example, Klondike III, a 200-megawatt wind farm located in Sherman County, Oregon, and owned by Iberdrola Renewables has been used by PPL Treasure State, Electric City Power, and Conoco Phillips in meeting the Montana requirements. Black Hills, which with the passage of Senate Bill No. 164 by the 2013 Legislature, is no longer subject to Montana's RPS or the CREP requirements, has exclusively used renewable energy attributes from the Happy Jack Wind Farm, owned by Duke Energy and located in Laramie County, Wyoming, in meeting the Montana standard. (Only about 2% of Black Hills' utility sales are to end users in Montana, and Black Hills has about 35 overall Montana consumers.)

The remaining 250 megawatts of certified eligible renewable resources for meeting the Montana standard come from wind, hydroelectric and one cogeneration facility and are located in Montana.

Wind is clearly the predominate resource used in meeting Montana's standard. In September the PSC certified the Flint Creek Hydroelectric Project as an eligible renewable resource that also meets CREP requirements. Flint Creek is a 2-megawatt hydroelectric project in Granite County. With the addition of Flint Creek, there are 15.8 megawatts of non-wind certified as an eligible renewable resource for meeting Montana's renewable portfolio requirements. Of those 15.8 megawatts about 15.5 megawatts are certified as CREPs. A little more than 20% of all CREPs are nonwind resources.

Domination by wind is not unexpected. In 2007 the Berkeley National Laboratory study, funded in part by the U.S. Department of Energy, conducted an analysis of 28 state-or utility-level RPS programs in 18 different states. (Montana was not included.) The study found that wind was the dominant technology used in meeting the requirements and that was expected to continue.

> "Perhaps not surprisingly, wind is expected to be the dominant technology, representing an aggregate 62% of incremental state RPS generation across all of these studies combined."[13]

The definition of a renewable resource under Montana law also has changed over time. In general, facilities must produce electricity from wind; solar; geothermal; water power, in certain cases; landfill or farm-based methane gas; gas produced during the treatment of wastewater; low-emission, nontoxic biomass; hydrogen derived from any of the sources noted above for use in fuel cells; compressed air, flywheel storage, hydroelectric pumped storage, and batteries; and the renewable energy fraction from production from a multiple-fuel process with fossil fuels. Large hydroelectric generation facilities are not included in Montana's RPS. The 2013 Legislature also added certain hydroelectric expansions to the mix.

Air quality improvements

Wind generation, which is primarily used in meeting Montana's RPS, is zero emission generation. Fossil fuel generation contributes to carbon dioxide emissions, nitrogen oxide emissions, sulfur dioxide emissions, mercury emissions, particulates, and volatile organic compounds. For the purposes of this report in evaluating air quality, emissions are discussed using a one-to-one ratio in terms of emissions that are displaced by renewable generation as opposed to emissions that are eliminated by most renewable generation.[14]

> "One of the obvious benefits of wind energy is that the production of electricity from this source involves zero direct emissions of air pollutants. In contrast, fossil fuel-fired electric generation from coal, oil, or natural gas results in substantial direct emissions of numerous air pollutants that have adverse impacts on public health and the environment."[15]

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[13]"Weighting the Costs and Benefits of State Renewables Portfolio Standards: A Comparative Analysis of State-Level Policy Impact Projections," Cliff Chen, Ryan Wiser, and Mark Bolinger, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, March 2007, executive summary, page ii.

[14] The use of biomass facilities, which are not zero-emission facilities are not included in the calculations. There are no biomass facilities currently certified by the PSC as eligible renewable resources in meeting Montana's RPS.

[15]"Wind Energy and Air Emission Reduction Benefits: A Primer", D. Jacobson, National Renewable Energy Laboratory, February 2008.

In 2006 when Southern Montana Electric Generation and Transmission proposed building a 250-megawatt coal-fired plant,[16] an Environmental Impact Statement (EIS) was completed by the federal Rural Utilities Service and Montana Department of Environmental Quality (DEQ). As the EIS was drafted, it included 29 alternatives to the project, including a 250-megawatt wind farm or a combination of wind, hydroelectric and solar projects.

> The alternative concluded, "Overall, with regard to environmental impacts, both variants of this combination alternative would be superior to the proposed action because of the elimination of air emissions, water consumption and waste generation other than minor air quality impacts during construction and storm water impacts." [17]

There are generally air quality improvements when renewable generation reduces fossil fuel combustion at an existing plant or reduces or eliminates the need to build or operate new fossil fueled power plants.[18] Electricity produced by a renewable resource, such as wind, is matched by an equivalent decrease in electricity generation at another resource -- simply because a utility must balance supply with demand at all times. In most cases the generation that is displaced is that of a fossil-fuel plant because of higher fuel costs. Increased renewable generation, in general, means reduced fossil-fuel generation, reduced emissions, and improved air quality. In the larger context that equation is apparent in Montana, but the details deserve a closer look.

Table 4 quantifies the emissions potentially displaced by certified eligible renewable resources used to meet the Montana RPS based on generation. It also provides some comparisons to existing emissions in Montana.

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[16]Due to environmental and financial pressures, Southern changed Highwood to a two-phase project, with the first phase being a 40-megawatt natural gas project

[17]Southern Montana, EIS, page 2-47.

[18]"Weighting the Costs and Benefits of State Renewables Portfolio Standards: A Comparative Analysis of State-Level Policy Impact Projections," Cliff Chen, Ryan Wiser, and Mark Bolinger, Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, March 2007, executive summary, page 6.

Table 4

Actual Emissions and Emissions Potentially Displaced by RPS Resources			
Actual Emissions			
Resource	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxides
Colstrip (2007)[19]	18 million tons[20]	16,992 tons[21]	31,584 tons
Colstrip (2011)	14 million tons	12,225 tons	15,838 tons
Overall in Montana (2010 -- All sources)	34.9 million tons	19,895 tons	21,723 tons
Emissions Displaced by RPS Resources (Natural Gas)[22]			
Resource	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxides
542 megawatts[23]	1.1 million tons	95 tons	1,615 tons
250 megawatts[24]	499,320 tons	43.8 tons	788 tons
Emissions Displaced by RPS Resources (Coal)			
542 megawatts[25]	2.1 million tons	13,300 tons	5,700 tons
250 megawatts[26]	963,600 tons	6,132 tons	2,628 tons

[19] Colstrip Steam Electric Station Units 1-4 is a 2,100-megawatt coal-fired power plant.

[20] http://www.eia.gov/environment/emissions/state/analysis/. All carbon dioxide emissions were gathered using EIA reports.

[21] http://ampd.epa.gov/ampd/QueryToolie.html. All sulfur dioxide and nitrogen oxide emissions were gathered using the EPA's Air Markets Program data.

[22] For an overview of calculations, see **Appendix A**.

[23] This includes all certified eligible renewable resources, located in Montana and delivering electricity into Montana. A 40% capacity factor was used for output. Actual output may be higher or lower than 40%. By way of example, Judith Gap averages 38% capacity, Gordon Butte has averaged 45%, and Klondike III has been estimated at 30% to 34% capacity.

[24] This includes only certified eligible renewable resources located in Montana. A 40% capacity factor was used in determining output.

[25] See footnote 23.

[26] See footnote 24.

Montana is also a net exporter of energy -- largely due to the four privately owned coal-fired units at Colstrip, which have a combined capability of 2,100 megawatts. NorthWestern Energy's share of Colstrip accounts for about 6% of the total generation in the state. There isn't a direct correlation between Montana's RPS to generation activity at the Colstrip facility -- an important factor when examining air emissions in Montana. The RPS is localized to Montana, whereas Colstrip is an extremely large baseload facility serving a geographically diverse area.

In early 2013 the federal Energy Information Administration (EIA) released a report noting that carbon dioxide emissions in Montana totaled 34.9 million tons in 2010. This translated into about 35 tons per resident and an increase of more than 11% over the last decade. It also pegged Montana as having one of the highest per capita greenhouse gas emission rates in the country. The EIA goes on to estimate that carbon dioxide emissions from fossil fuels in the U.S. declined overall by 4% in 2012.

In 2007, the Center for Climate Strategies (CCS), a nonprofit organization, prepared a greenhouse gas inventory under a contract with the Department of Environmental Quality (DEQ). The inventory provided a thorough look at emissions in Montana. The findings showed that emissions associated with electricity consumption in Montana were much lower, about half, than those associated with electricity generation. To put air quality issues into perspective then, it is important to make a distinction as to whether the emissions reflect the state's electricity consumption or its generation. In most cases, the emissions reported by the EIA or tracked by the Environmental Protection Agency are based on electricity generated in Montana. The emissions include Colstrip, which again can't be correlated with Montana's RPS.

Concerns also have been raised that reducing the output of a fossil fueled plant in response to the addition of renewable energy to the grid can reduce the efficiency of that fossil-fueled power plant. In September 2013, the National Renewable Energy Laboratory released a report calculating the emissions and costs of power plant cycling needed to accommodate increased renewable generation. The report spells out a "high-wind" scenario, with one-fourth of the energy in the entire Western grid coming from wind and solar resources, reducing the carbon footprint in the Western grid by about one-third.

> "The study also finds that the carbon emissions induced by more frequent cycling are negligible (<0.2%) compared with the carbon reductions achieved through the wind and solar power generation evaluated in the study."[27]

Sulfur dioxide emissions were found to be 5% less than they would be if cycling of fossil-fueled generators wasn't necessary and nitrogen oxide emissions would be 2% less.

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[27]"The Western Wind and Solar Integration Study Phase 2: Executive Summary," National Renewable Energy Laboratory, Debra Lew and Greg Brinkman, September 2013.

Conclusion

Capturing the environmental benefits of Montana's RPS is challenging. However, it is apparent that renewable generation in Montana has increased. There is no universal model for analyzing the environmental impacts of a state RPS. The information provided above offers a general measurement of some of the environmental outcomes that may be reviewed in conjunction with certified eligible renewable resources in Montana, not a measurement of the environmental success or failure of Montana's RPS.

The information offers a simplified look at potential environmental impacts, using the parameters outlined in SJ 6. At the November 8 meeting in Helena, ETIC members will hear from representatives of the DEQ, Montana electric utilities, and potentially the National Renewable Energy Laboratory. The speakers, who are general experts on environmental topics, are expected to provide a wealth of additional information on this topic. This report will be revisited based on the input provided to the committee.

Appendix A

I. Electricity Output of All Certified Eligible Renewable Resources:
542 MW averaging approximately 40% Capacity Factor
Output = Generation MW x 8760 hours/year x % Capacity Factor

- 542 MW x 8760 hours/year x 0.40 = 1.9 million MWh per year

Carbon Dioxide Emissions Displaced:
Average U.S. emissions rates from natural gas-fired generation = .57 tons/MWh of carbon dioxide[28]
Average U.S. emissions rates from coal-fired generation = 1.1 tons/MWh of carbon dioxide
1.9 million MWh x .57 tons/MWh = 1.1 million tons of equivalent carbon dioxide
1.9 million MWh x 1.1 tons/MWh = 2.1 million tons of equivalent carbon dioxide

- (Natural gas displacement) All certified eligible renewable projects displace 1.1 million tons of carbon dioxide per year
- (Coal displacement) All certified eligible renewable projects displace 2.1 million tons of carbon dioxide per year

Sulfur Dioxide Emissions Displaced:
Average U.S. emissions rates from natural-gas fired generation = .00005 tons/MWh of sulfur dioxide[29]
Average U.S. emissions rates from coal-fired generation = .007 tons/MWh of sulfur dioxide.
1.9 million MWh x .00005 tons/MWh = 95 tons of equivalent sulfur dioxide
1.9 million MWh x .007 tons/MWh = 13,300 tons of equivalent sulfur dioxide

- (Natural gas displacement) All certified eligible renewable projects displace 95 tons of sulfur dioxide per year.
- (Coal displacement) All certified eligible renewable project displace about 13,300 tons of sulfur dioxide per year.

Nitrogen Oxide Emissions Displaced:
Average U.S. emissions rates from natural-gas fired generation = .0009 tons/MWh of nitrogen oxides[30]
Average U.S. emissions rates from coal-fired generation = .003 tons/MWh of nitrogen oxides
1.9 million MWh x .0009 tons/MWh = 1,615 tons of equivalent nitrogen oxides
1.9 million MWh x .003 tons/MWh = tons of equivalent nitrogen oxides

- (Natural gas displacement) All certified eligible renewable projects displace 1,615 tons of nitrogen oxide per year.

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[28] http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html

[29] Ibid

[30]Ibid

- (Coal displacement) All certified eligible renewable projects displace 5,700 tons of nitrogen oxide per year.

II. Electricity Output of Eligible Renewable Resources Certified and Located in Montana:
250 MW averaging approximately 40% Capacity Factor
Output = Generation MW x 8760 hours/year x % Capacity Factor
- 250 MW x 8760 hours/year x 0.40 = 876,000 MWh per year

Carbon Dioxide Emissions Displaced:
Average U.S. emissions rates from natural gas-fired generation = .57 tons/MWh of carbon dioxide
Average U.S. emissions rates from coal-fired generation = 1.1 tons/MWh of carbon dioxide
876,000 MWh x .57 tons/MWh = 499,320 tons of equivalent carbon dioxide
876,000 MWh x 1.1 tons/MWh = 963,600 tons of equivalent carbon dioxide
- (Natural gas displacement) Certified eligible renewable projects located in Montana displace 499,320 tons of carbon dioxide per year
- (Coal displacement) Certified eligible renewable projects located in Montana displace 963,600 tons of carbon dioxide per year

Sulfur Dioxide Emissions Displaced:
Average U.S. emissions rates from natural-gas fired generation = .00005 tons/MWh of sulfur dioxide
Average U.S. emissions rates from coal-fired generation = .007 tons/MWh of sulfur dioxide.
876,000 MWh x .00005 tons/MWh = 43.8 tons of equivalent sulfur dioxide
876,000 MWh x .007 tons/MWh = 6,132 tons of equivalent sulfur dioxide
- (Natural gas displacement) Certified eligible renewable projects located in Montana displace 43.8 tons of sulfur dioxide per year.
- (Coal displacement) Certified eligible renewable projects located in Montana displace 6, 132 tons of sulfur dioxide per year.

Nitrogen Oxide Emissions Displaced:
Average U.S. emissions rates from natural-gas fired generation = .0009 tons/MWh of nitrogen oxides
Average U.S. emissions rates from coal-fired generation = .003 tons/MWh of nitrogen oxides
876,000 MWh x .0009 tons/MWh = 788 tons of equivalent nitrogen oxides
876,000 MWh x .003 tons/MWh = 2,628 tons of equivalent nitrogen oxides
- (Natural gas displacement) Certified eligible renewable projects located in Montana displace 788 tons of nitrogen oxide per year.
- (Coal displacement) Certified eligible renewable projects located in Montana displace 2,628 tons of nitrogen oxide per year.

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