MONTANA'S RENEWABLE PORTFOLIO

◈ 10 YEARS OF RENEWABLE ENERGY ◈

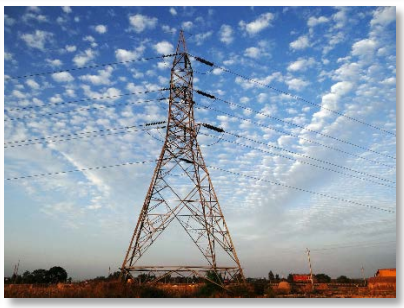
THE ECONOMIC BENEFITS FOR MONTANA

Prepared for

Renewable Northwest and Montanans for Good Jobs & Clean Air








AUTHORS

John O'Connor
Brent Brock
Gary Gannon

sciGaia™
Semantic Collective Intelligence
PO Box 10505
Bozeman, MT 59719
www.sciGaia.com

INQUIRIES

Please Contact
Gary Gannon
406.586.3388

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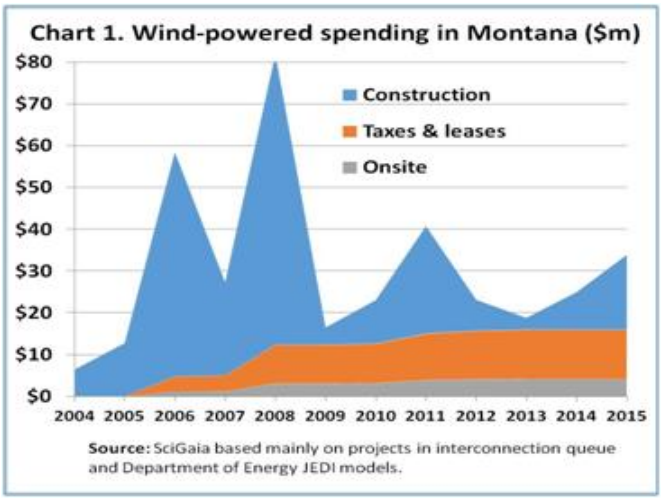
I. EXECUTIVE SUMMARY

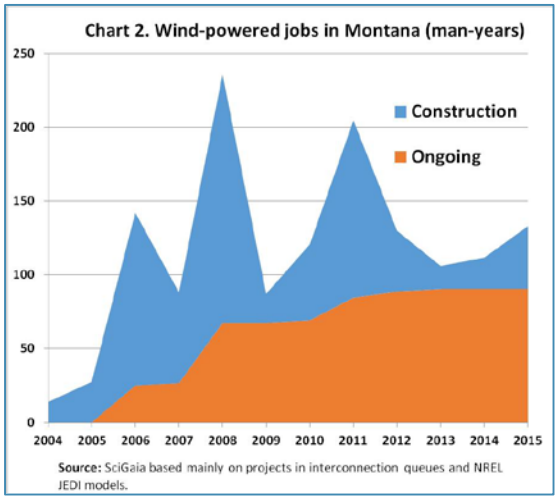
2015 marks the tenth anniversary of Montana's Renewable Power Production and Rural Economic Development Act of 2005, also known as the Renewable Portfolio Standard (RPS). It also marks the final step in the RPS, now requiring public utilities (and other competitive electricity providers) to purchase 15% of their retail power from renewable resources. The Act succeeded by providing the foundation for development of new, clean, beneficial, and cost effective energy resources in Montana while stimulating the economy. During this decade, wind power has grown from zero to 6.5% of Montana's electricity generation. This figure is less than 15% because total generation includes power not regulated under the RPS such as generation for power exports and to supply rural electric cooperatives. As a rural development strategy, wind generation properties in Montana now have a market value near $1 Billion - all outside of towns and cities. This represents twice the property value in those rural areas as compared with other types of electric generation facilities outside of towns and cities.[1]

This report focuses on how the State and its citizens have been impacted by this legislation, and how the future of renewables in Montana may evolve - depending upon actions taken by governments, businesses, and the public. We will also discuss other promising forms of renewable energy and storage that have not been widely adopted in the State, but likely hold promise for the future.

Providing new renewable energy solutions required a great deal of human planning, physical work, money, machinery, and infrastructure. Econometric modeling estimates that developing and operating wind power in Montana generated nearly $400 million in spending, and 1,400 man-years of work over the RPS decade. Excluding construction booms associated with developing wind assets, wind is estimated to add close to $16 million to the annual Gross State Product and about 90 jobs to yearly employment.

Consistent with most wind studies, our estimates rely on Department of Energy (DoE) Jobs and Economic Development Impact (JEDI) models that 'drill down' from global economic measures to impacts on a State. This study recasts results to show when (and, in body of report, where) Montana benefited. As summarized in Charts 1 and 2, this helps show construction benefits are large but vary in size over time; ongoing jobs and outlays (operation & maintenance plus indirect effects) rise steadily over time.





Construction peaks and troughs arise from short-term factors largely beyond Montana's control, including the great recession that started in 2008. For example, in recent years renewables have been trying to penetrate a slack electricity market while fossil fuel prices are low. Additionally there was uncertainty about availability of Federal Production Tax Credits or PTC - a federal incentive that provides financial support for the development

of renewable energy facilities. Estimates in Charts 1 and 2 for 2013-15 are influenced by the short-term extension of PTC in late 2014.[2] This study uses anecdotal information to consider projects that may have qualified for the extension. These would add 285MW of nameplate wind capacity by end-2016 (present capacity is 670MW); project timelines imply some prior spending and jobs.

Beyond that, this study identifies another 1,400 megawatts (MW) of nameplate wind capacity planned and technically feasible by 2020, which would mean 2,300MW of capacity. That is less than the capacity of smaller States like Washington and Oregon, yet wind power in Montana would then be adding $55 million to Gross State Product and 300 jobs to yearly employment.

That 2020 portfolio would leave Montana better positioned for the long term price 'twist' DoE projects: costs for renewable technology become less expensive while fossil fuel prices rise. Policy choices made by Montana in the near term will influence the likelihood of such a portfolio developing. As the Department of Energy's *Wind Vision* put it:

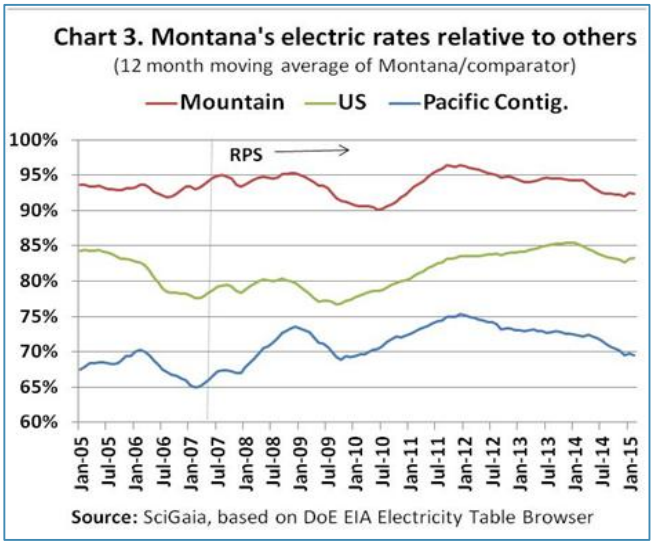
> *The path needed to achieve 10% wind by 2020… requires new tools, priorities, and emphasis beyond those forged by the wind industry in growing to 4.5% of current U.S. electricity demand. Consideration of new strategies and updated priorities as identified in Wind Vision could provide substantial positive outcomes for future generations.*

Detailed discussion of policies is beyond this paper but it is worth noting that the Database of State Incentives for Renewables and Efficiency (DSIRE) treats RPS as one of 12 regulatory policies and 51 financial incentives for Montana. Their joint effect in turn depends on what other States, and the Federal Government, do—or don't do. Absent a Federal PTC, for example, some States may sweeten financial incentives; perhaps enough to offset Montana's greater wind potential. Nonmonetary considerations may be as important. For example, the latest National Renewable Energy Laboratory (NREL) report on Wind Integration and Transmission concludes, "flexibility, especially at high levels of wind penetration, may be the most critical wind integration issue" and "physical flexibility without the institutional ability to access this flexibility may be insufficient."[3]

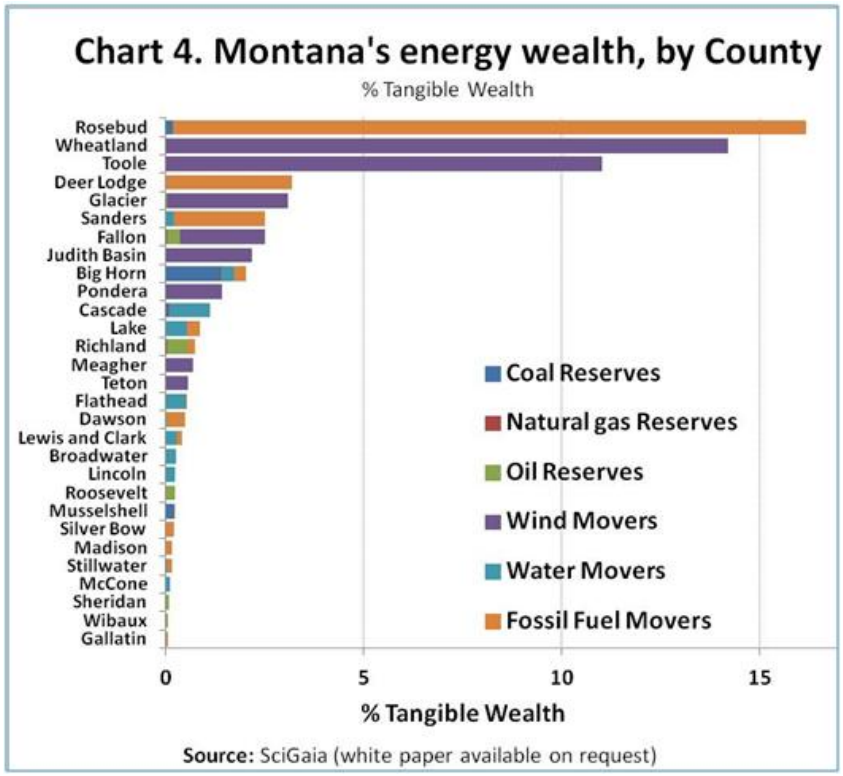
The big payoff, then, may be how RPS prepared the State for major changes in the energy sector. Montana has long been an energy exporter; first as coal and then as electricity based on coal and hydro plants.[4] Almost half the State's electricity is for export, or bulk power. This gets the State about twice the infrastructure it needs for in-State sales. Beyond doubling jobs and investments, satisfying the bulk power market helps keep retail rates low by spreading fixed costs for new, more efficient, technology. Montana's RPS and related government actions helped it keep its share in a bulk power market demanding more renewable energy.

This study agrees with Montana's Energy and Telecommunications Interim Committee (ETIC) staff report to the 64th Legislature that RPS had "limited rate impacts for most Montana customers." Beyond complications of apportioning costs between bulk and retail power, it finds much depends on which factors one chooses to consider. Montana's RPS did not apply to all electricity producers or providers; some projects were begun before RPS; some out-of-State renewables were acceptable; the Public Service Commission considers many factors in deciding which rate increases are justified; etc. The bottom line is Montana's retail rates were and are below comparators; relative rates are about where they were before RPS (Chart 3). In general, rates in Montana have been 5% lower than in Mountain States; 15% below the US average, and 25% or more below the average for the Contiguous Pacific States.

It should be noted that RPS focused on electric utilities but most wind projects have been developed by independent power producers[5] in areas traditionally served by power cooperatives. Most Counties now supplying wind power were only electricity consumers before the Act. That has implications for power transmission and distribution (T&D), which employs more people in Montana (1,752) than generation (714). DoE expects transmission costs to rise, while generation costs fall, between now and 2030. Only modest distributed generation or 'grid defection' is projected nationally[6] but these could be large, and transformative, for the productive base, or wealth, of rural Counties; particularly those that may be able to attract businesses that require significant electricity.



This study considers local differences not only in renewable energy sources (wind, solar, etc.) but also how wind fits in the productive base, or wealth, of Montana's Counties. It uses wealth metrics, previously only available for national analyses, to do this (white paper available on request). Chart 4, for example, relates renewables to the full portfolio of Tangible Assets, County by County. It shows wind is already about as important to the economies of Wheatland and Toole Counties, as measured by Tangible Assets, as coal and coal-fired power are in Rosebud County.



II. INTRODUCTION

In 2005, Montana became the 23rd State to set a Renewable Portfolio Standard (RPS); 47 States now have an RPS. A RPS is a subset of rules, regulations, and policies for renewable energy, normally accompanied by but separate from financial incentives. [7] States differ not only in their mix of policies and incentives but also in how they are administered; each mix in turn is shaped by Federal policies and incentives, which changed markedly during Montana's RPS decade. Examples of separate but related policies are net metering and interconnection; tax rates and low interest loans are examples of financial incentives.

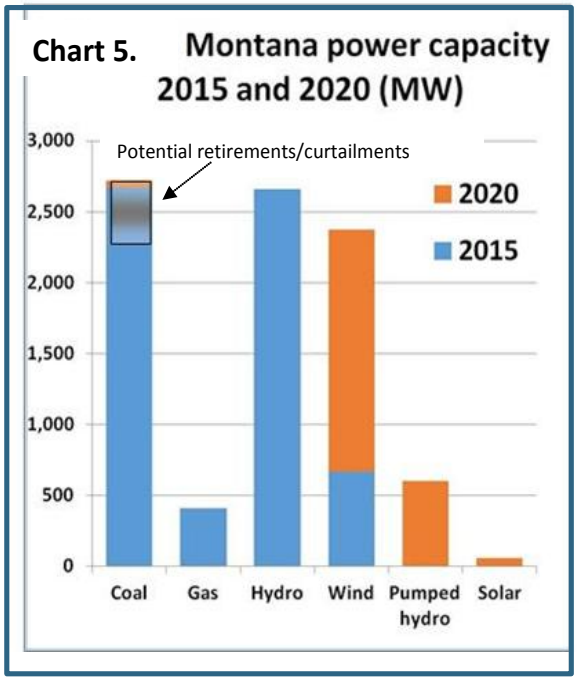
This paper focuses on the two goals of Montana's RPS explicit in its name: the Renewable Power Production and Rural Economic Development Act of 2005. It initially prescribed minimum reliance on specified renewables, for regulated public utilities, in specified projects; it evolved into a more inclusive scheme as the decade progressed[8] and renewables turned out to be good business, especially for the interstate or bulk power trade. Montana's RPS is administered by its Public Service Commission (PSC) and thus influenced by its policies for rate setting, etc. Hence, some attention is given to whether the RPS had a measurable effect on a key PSC goal: ensuring that electricity rates are just and reasonable.

Section III describes past results of the RPS. It answers three basic questions.

- **Part A** considers Investment, or 'How much money is invested in Montana's renewable energy and returned to the economy?'
- **Part B** considers Employment, or 'How many Montana jobs (temporary and permanent) has the RES created over the past 10 years?''
- **Part C** discusses electric rates, or 'How has the addition of renewable energy generation sources affected electric rates in Montana?'

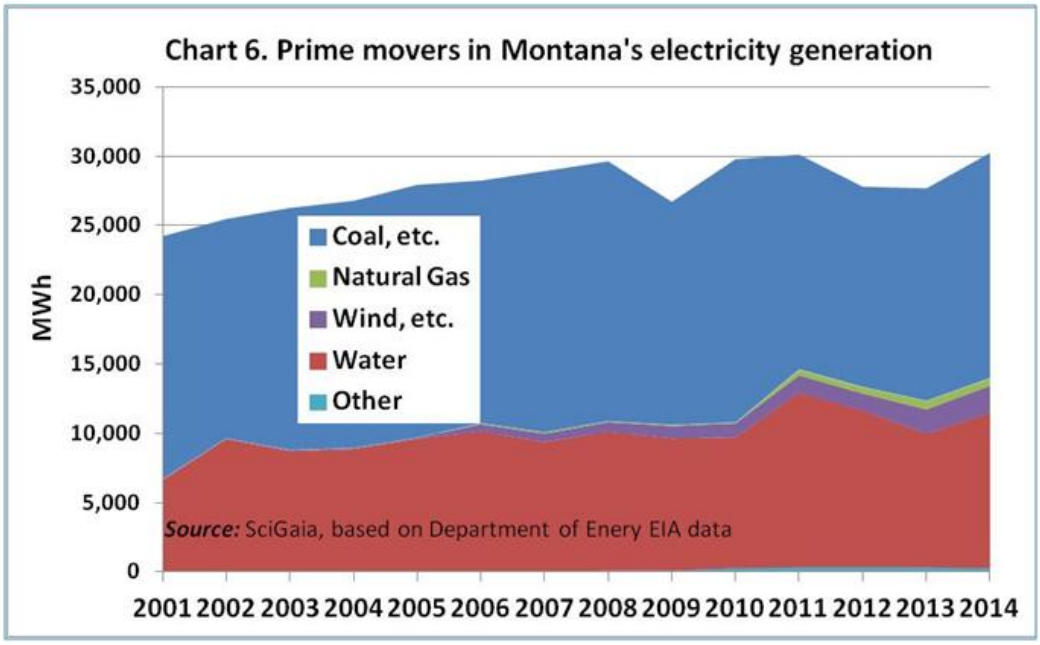
Section IV considers Montana's renewable future, and specifically what that means for jobs.

- **Part A** assumes a Business-As-Usual future. Using the US Department of Energy (DOE) Annual Energy Outlook for 2015 (AEO2015) Reference Case for the Western Electricity Coordinating Council (WECC) Northwest region. It means only modest change from results achieved by 2015.
- **Part B** uses the RPS as a framework for a 'bottom up' assessment of renewables projects that may be viable from a narrowly defined (generation) supply side perspective. These would add 37% to the State's existing nameplate capacity by 2020, as summarized in Chart 5.This analysis does not consider how to overcome supply-side constraints on transmission, or most likely markets to consume Montana's wind power on the demand side.



III. PAST RESULTS

Montana has long been a major energy exporter, first as coal and then as electricity based on coal and hydro plants. This gets the State about twice the energy infrastructure it needs for in-State sales. Beyond doubling jobs and investments, satisfying the bulk power market helps keep retail rates low by spreading fixed costs for new, more efficient, technology. In broad terms, then, Montana's RPS and related government actions help it keep its share in a bulk power market demanding more renewable energy.



In 2005, before RPS, fossil fuels (mainly coal) powered 65% of electricity generation, with hydroelectric plants providing almost all the rest. By 2014, coal had fallen to 54%, with hydro rising a bit to 37% and natural gas powering 2%--and wind at 6.5% (see Chart 6). Total generation depends on demand, which was generally flat during the RPS decade, at least in part due to Demand Side Management (DSM) and energy efficiency (EE) policies in Montana and importers of its bulk power.

Sources & Methods

Like most previous studies of Montana's RPS,[9] this paper uses Department of Energy (DoE) Jobs and Economic Development Impact (JEDI) models to estimates total investment in as well as jobs generated by wind projects; how much of the total spend was in Montana; how much of that was earnings, land leases, property taxes, etc. In principal, the model uses simple, fixed, input-output coefficients from the US Bureau of Economic Analysis but wind power has such a short history that JEDI coefficients rely more on expert opinion[10] and seem to vary (above some minimum) as power functions of nameplate capacity. This means results have to be used circumspectly and are typically reported in highly aggregated form, often for the expected lifetime of some total MW capacity that may or may not be explained in detail. Such estimates are hard to relate to conventional socioeconomic indicators, notably Gross State Product and employment.

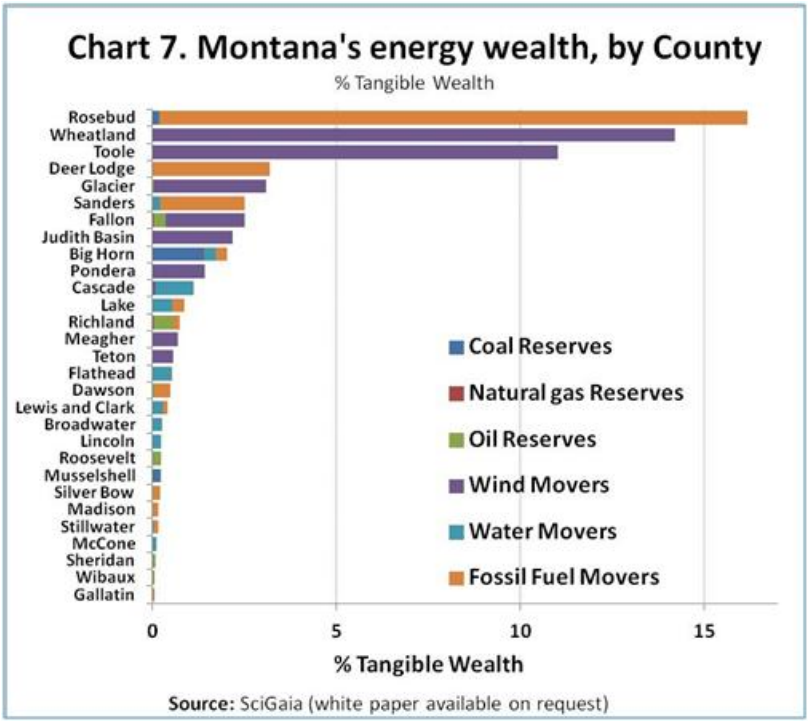
JEDI provides Montana-specific coefficients that produce results based on nameplate capacity. It allows additional data input, say reported total spending. However, additional data were found for too few projects, and too poorly documented, for use here. The model estimates construction outlays and then indicates annual value added, etc., assuming a standard timeline of a bit over three years. Other sources[11] indicate the timeline begins with planning and interconnection agreement with a 'balancing authority'. For that reason, this study considers projects in-service when listed as such (or active) in various interconnection reports.

Model results for construction investment and jobs are then backtracked. Seventy percent is assigned to the in-service year; 20% to the previous year; 10% to the earliest year (implicitly related to planning and interconnection agreement.) Model results for annual operation are assumed to begin with the in-service year and remain the same in subsequent years. These are split between direct (e.g., onsite labor) and indirect effects. In sum, specific projects are run through JEDI models; results are aggregated to gauge where (County) and when (year) capacity was added; and investment and jobs had impacts. This supports analysis of similarities and differences within Montana, in terms of costs and benefits of alternative energy strategies.

A. INVESTMENT

This Part answers the question: how much investment wind generation has brought into Montana, and how much was returned to the economy? This sounds like one question but is actually two.

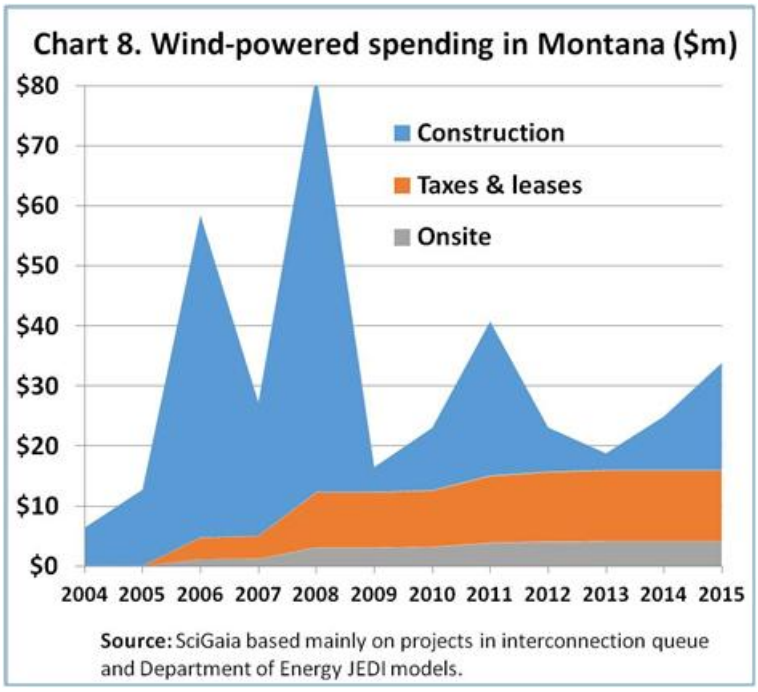
The best measure of how much investment wind generation has brought into the State, and wind's role in Montana's economic development, is the $1 Billion value County property assessors put on wind generation properties, for 2014.[12] Importance to rural economies is evident in the fact that this is ***twice the value*** of all (other) electric generation real property outside of towns/cities.[13] For the nine Counties involved, wind generation properties comprise 11% of total assessed value; ranging from almost half the total in Toole and Wheatland, to a fifth in Glacier, and a tenth in Judith Basin, to a lesser role elsewhere (in descending order: Pondera, Meagher, Teton, Fallon, and Cascade). Chart 7 puts wind-powered investments in context by relating them to a broad measure, Tangible Wealth. For example, wind movers are already almost as important in the productive base of Wheatland (14%) and Toole (11%), as coal and coal-fired power plants are in Rosebud (16%). Tangible Wealth recognizes and values all assets in a tax assessment plus fossil fuel reserves and untaxed property, notably Federal land as net present value of Federal Payments in Lieu of Taxes; water and water rights; non-timber forest services; and some other assets, as explained elsewhere (white paper on request).



The $1.2 billion that econometric modeling (JEDI) suggests was invested in Montana wind projects through 2015 is in line with the $1 Billion of assessed value for wind generation properties in 2014. However, two-thirds of the value in models goes for turbines and equipment not manufactured in Montana, supply chain outlays beyond the State etc. Models yield only $0.3 billion as local construction spending but, as property assessment makes clear, the whole $1.2 billion is literally invested in Montana.

On the other hand, local construction spending is only one way wind generation returns money to the State economy. It also returns money through annual spending, over the operational life of the investment. This return is often expressed as the net present value of the stream of operational or annual spending expected over, say 30 years. However, this study estimates how much has been returned to the State economy by distributing local construction spending on actual projects over construction years and adding local spending from first year of operation until now. As shown in Chart 8, this adds up to $385 million:

- $259 million for construction,
- $77 million for taxes and $16 million in land leases, and
- $33 million in onsite costs (mainly labor).



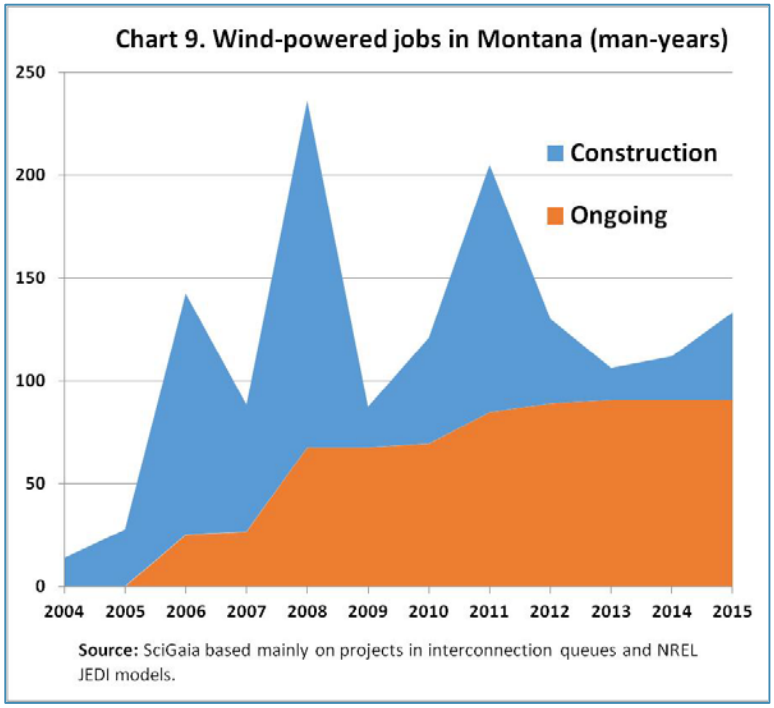
B. Man Years & Local Spending

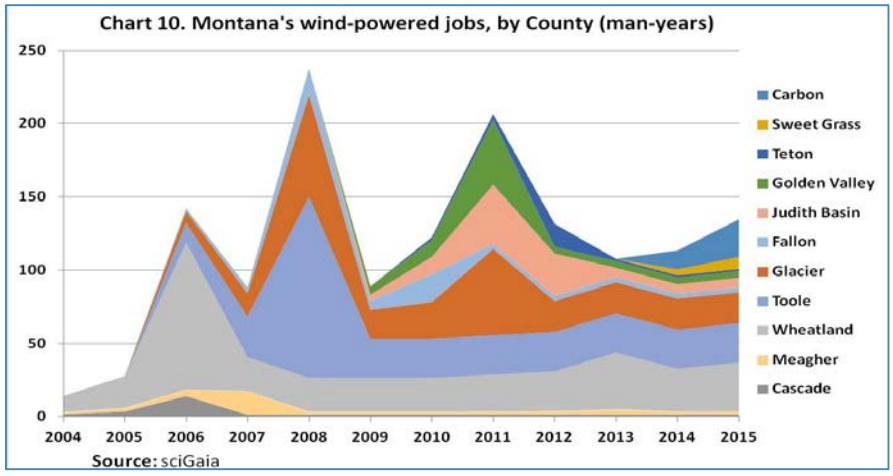
This Part answers the question: How many Montana jobs (temporary and permanent) has the RES created over the past 10 years? 'Temporary' is interpreted to mean jobs during construction and permanent as those for operational wind farms, directly as onsite labor and indirectly as jobs created in the local supply chain. Model estimates of jobs are full time equivalent employment, while job figures reported by investing companies are likely to count number of individuals or a simple total of full and part time jobs. For this reason, this paper uses the term, man-years, to describe job estimates from models.

The results, as shown in Chart 9, is an estimate of 1,400 jobs created by wind generation in the RPS decade. This comes from:

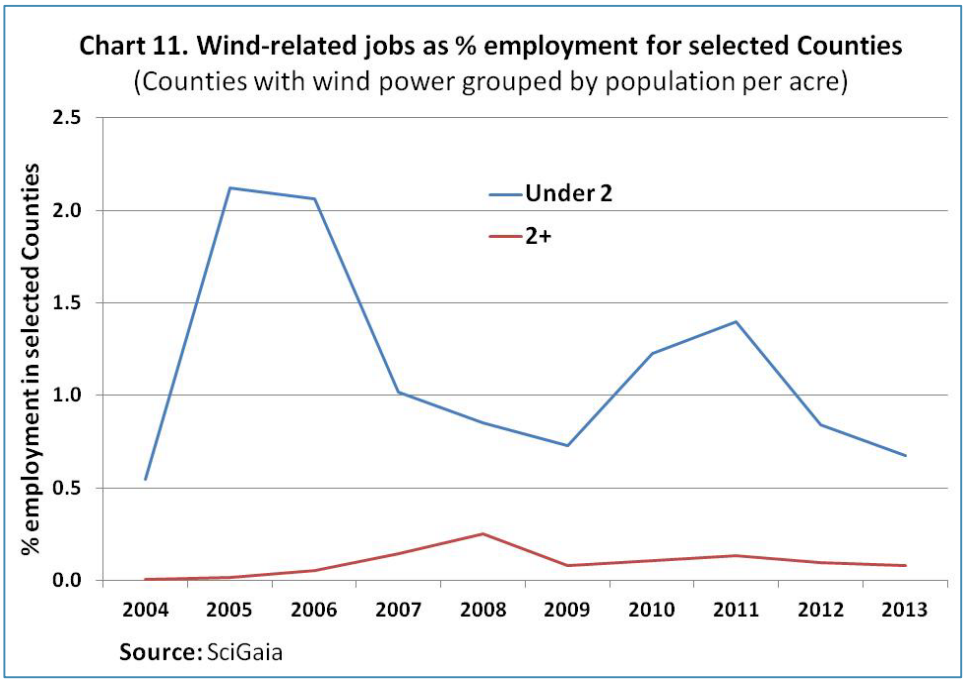
- 740 jobs during construction,
- 700 for onsite labor and jobs in the State arising from higher economic activity, including those for local business-to-business operations.

As with investment, however, the relevance of these job numbers to the RPS depends on where they occur. Intuitively, jobs in utility-scale wind projects will be in rural areas but the significance for rural development depends on where wind-powered jobs are. Chart 10 therefore recasts the 1,400 jobs to show the County where wind farms are located.





This study also considered various classifications of the rural-urban continuum, to assess the role of the RPS and related measures in promoting rural economic development. For example, using a simplified split of the United States Department of Agriculture (USDA's) 12 category Urban Influence Code allocates most wind power to the more rural codes. A simpler approach was then used, dividing Counties based on population density (persons per acre), as shown in Chart 11. [14] Wind-related jobs have been a trivial factor in employment in Counties with higher population density but average out to about 1% of employment in less densely populated, and implicitly more rural, Counties. Put differently, in 2005 there were 515 unemployed in lower density Counties that created wind power; in 2014 there were only 486. In contrast, the number of unemployed in other lower density Counties rose (from 1,134 to 1,191), as did unemployment in higher density Counties that created wind power (from 3,370 to 3,813)—over the same period. In contrast, the number of unemployed in other lower density Counties rose (from 1,134 to 1,191) over the same period.



Many other explanatory factors have to be considered but adding a hundred wind powered jobs in lower density Counties seems analytically significant.

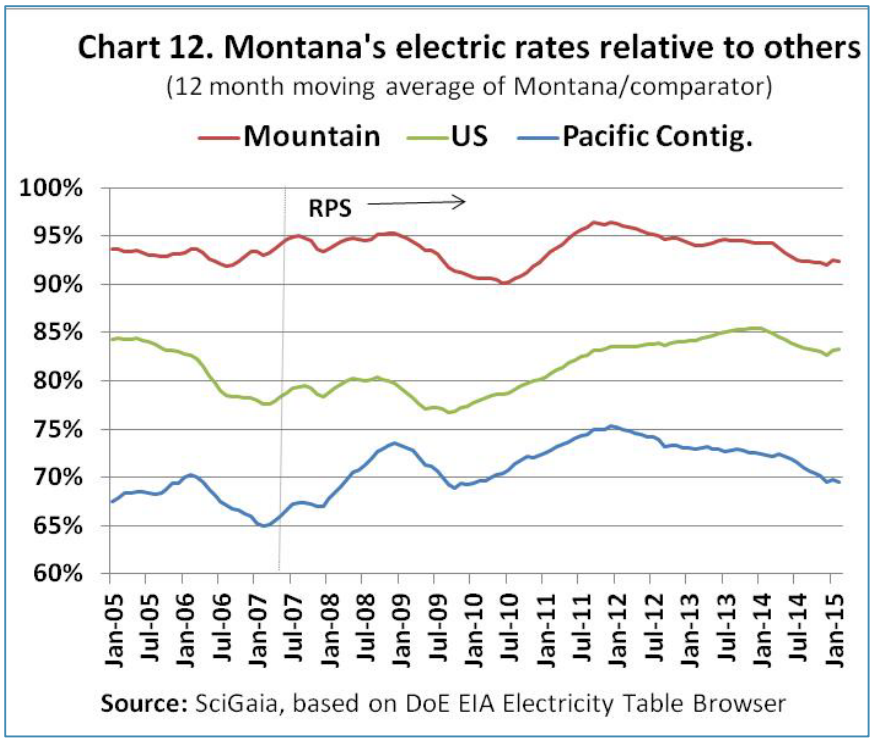
C. Retail Rates

This Part answers the question: *How has the addition of renewable energy generation sources affected electric rates in Montana?* This question was considered in detail in the ETIC report to the 64th Legislature. That report includes questionnaire responses from public utilities and competitive electricity producers covered by RPS. It found "limited rate impacts for most Montana customers."

The ETIC report details the procedural complexities in giving a more precise answer. Montana's RPS did not apply to all electricity producers or providers; some projects were begun before RPS; some out-of-State renewables were acceptable; the Public Service Commission considers many factors in deciding which rate increases are justified; etc. Some of those subject to Montana's RPS requirements reported it had little or no effect on their decision to add wind power to their portfolio, in part because they were already adding wind power, to satisfy RPS requirements of other States or because it made sense as a longer term strategy for diversifying asset portfolios.

Beyond the procedural complexities detailed in the ETIC report, there are various models for connecting input, one of which is wind generation, to one output—say retail electricity rates in Montana. For example, the Public Service Commission's hearings on Northwestern Energy's 2014 acquisition of major PPLM assets provide a detailed description of major differences between models for a pure (merchanting) market and a regulated or cost-of-service market like the one in Montana. Ultimately, regulated market models give some weight to qualitative factors, like rural economic development, that are not considered in a pure market model.

Moreover, the nature of an interconnected power grid means rates in Montana have to bear some relationship to rates elsewhere. This is even more so with half the State's power going to the bulk market. Electricity prices did rise in Montana and elsewhere, between 2005 and 2015; the rate of increase varied widely across retailers; there was no clear difference in the variance between those subject to RPS and others. This study therefore considers the bottom line to be how Montana's average retail rates compared, over time, with those of its neighbors. As shown in Chart 12, Montana's rates were and remain lower than those of comparators; they are about where they were before RPS. In general, rates in Montana have been 5% lower than in Mountain States; 15% below the US average, and 25% or more below the average for the Contiguous Pacific States.



It is worth adding that public utilities, those nominally most affected by RPS, increased their market share (relative to independent power producers) from an average of 23% in years up to 2010, to an average of 29% more recently. Considering that electric utility companies were required to obtain 15% of their electricity from 'new'

renewable sources, this is an indirect indicator that the requirement did not overly burden such businesses, or weaken their position with retail customers.

IV. MONTANA'S RENEWABLE ENERGY FUTURE

This Section considers the question: How many Montana jobs (temporary and permanent) will RPS help create in future? The short answer is it depends on how much electricity Montana can market in that future.

The 'top-down' answer in Part A uses DoE analyses that basically start by projecting demand for electricity and then distributing it regionally, with the Northwest Power Plan (NWPP) being the most important for Montana. It suggests wind-powered man-years, etc., stay pretty much as they are now for the next fifteen years; rising modestly thereafter as low cost renewable technology and high fossil fuel costs become the norm.

Part B, in contrast, offers a 'bottom-up' assessment by summing data for renewable projects in Montana that have a reasonable expectation of being in-service by 2020, given interconnection queue agreements and similar evidence, It suggests wind energy related man-years, etc., could triple by 2020.

The large difference shows a critical gap in tools available to answer such questions. As DoE's Wind Vision put it,

> *"The path needed to achieve 10% wind by 2020… requires new tools, priorities, and emphasis beyond those forged by the wind industry in growing to 4.5% of current U.S. electricity demand. Consideration of new strategies and updated priorities as identified in Wind Vision could provide substantial positive outcomes for future generations."*

Over-simplifying, metrics like those in Part A make sense for decision-making at the US or regional level while those in Part B reflect decision-making by individual businesses and Counties. Since Montana regulates much of its power system, and PSC bases rates on cost-of-service, it has a need to know—at the State level—how far apart these stakeholders' positions are, and consider policies and incentives that would harmonize them. It is even arguable that this is the Generation Gap for State decision-making.

Part C examines one possible scenario under EPA's proposed Clean Power Plan (CPP) as an example of how that Policy Zone may be measured

A. TOP-DOWN RESULTS

Experts expect demand for energy to move in line with population growth; or less, if Demand Side Management and Energy Efficiency programs continue to cut electricity required per dollar of Gross National Product (GNP). If Montana evolves in line with the Reference Case in AEO2015, for the WECC Northwest Power Pool (NWPP), it will only add an average of 0.3% per year to total nameplate capacity between 2015 and 2020; and 0.6% per year over the following twenty years. For NWPP as a whole, this means renewables, broadly defined, would have 69% of nameplate capacity in 2040 or about the same as now since conventional hydro is essentially unchanged and hence a declining percentage in a slightly rising total. Capacity for coal-fired plants declines in absolute terms in 2021, when some older plants are retired, but otherwise stays fixed (unless market forces or new carbon regulations or taxes make coal more expensive and less acceptable by the public and the market). Only wind has a significant increase in nameplate capacity, accounting for 19.0% of the total in 2040, compared to

14% today, but that relative increase doesn't occur until after 2030. However, new policy initiatives in Northwest states or potential breakthroughs in battery storage and new technology might significantly change the equation.

DoE's Reference Case supposes policies, including RPS, persist without expansion. In particular, it does not consider effects of EPA's proposed Clean Power Plan (CPP) or schemes that would attach a price to carbon emissions. It presumes Montana utilities have to power 15% of electricity with renewables but that floor is not raised; unchanged interconnection and net metering policies, financial incentives, etc. The main change it does show reflects an expected price 'twist' as fossil fuel prices rise and costs of renewable technologies fall.

Since that is projected for 2030 and beyond, Top-Down analysis essentially means Montana's energy future is just more of the present. Jobs will settle in around 100, essentially in the Counties that already have wind generation properties.

B. BOTTOM- UP RESULTS

Detailed information is available about electricity generation, transmission, and distribution. Of particular importance to this study, balancing authorities [15] require extensive study of interconnections —starting with a request to get into the 'queue.' Their data were culled to measure Past Results (in previous Section) and those with signed interconnection agreements but not yet in-service (or active) are considered here. Those reports show projects may be withdrawn even after reaching this stage if there are unanticipated permitting issues; feasibility studies suggest unexpectedly higher connection costs; etc. However, a fair bit is spent getting to this stage so listed projects deserve serious consideration.

In this section, therefore, this study models proposed projects in the interconnection queue as it does in-service (and active) projects. Feasibility studies and local knowledge were used to qualify expected in-service date and MW capacity that will be allowed to interconnect. The list goes beyond wind projects, so this exercise was used to take stock of progress across the technologies considered in the RPS. For completeness, the exercise also sought data on resources not contained in Montana's RPS, notably small-scale solar and wind, geothermal energy, and non-power dams. The result is the inventory in Item 1. Item 2 recasts the findings as projections for charts in Section II, above.

1) FUTURE RENEWABLE ENERGY DEVELOPMENT POTENTIAL

Montana's is rich in a number of 'new' renewables resources in addition to wind. The others have not had a measurable impact through 2015 but there is strong evidence these resources could be poised for growth.

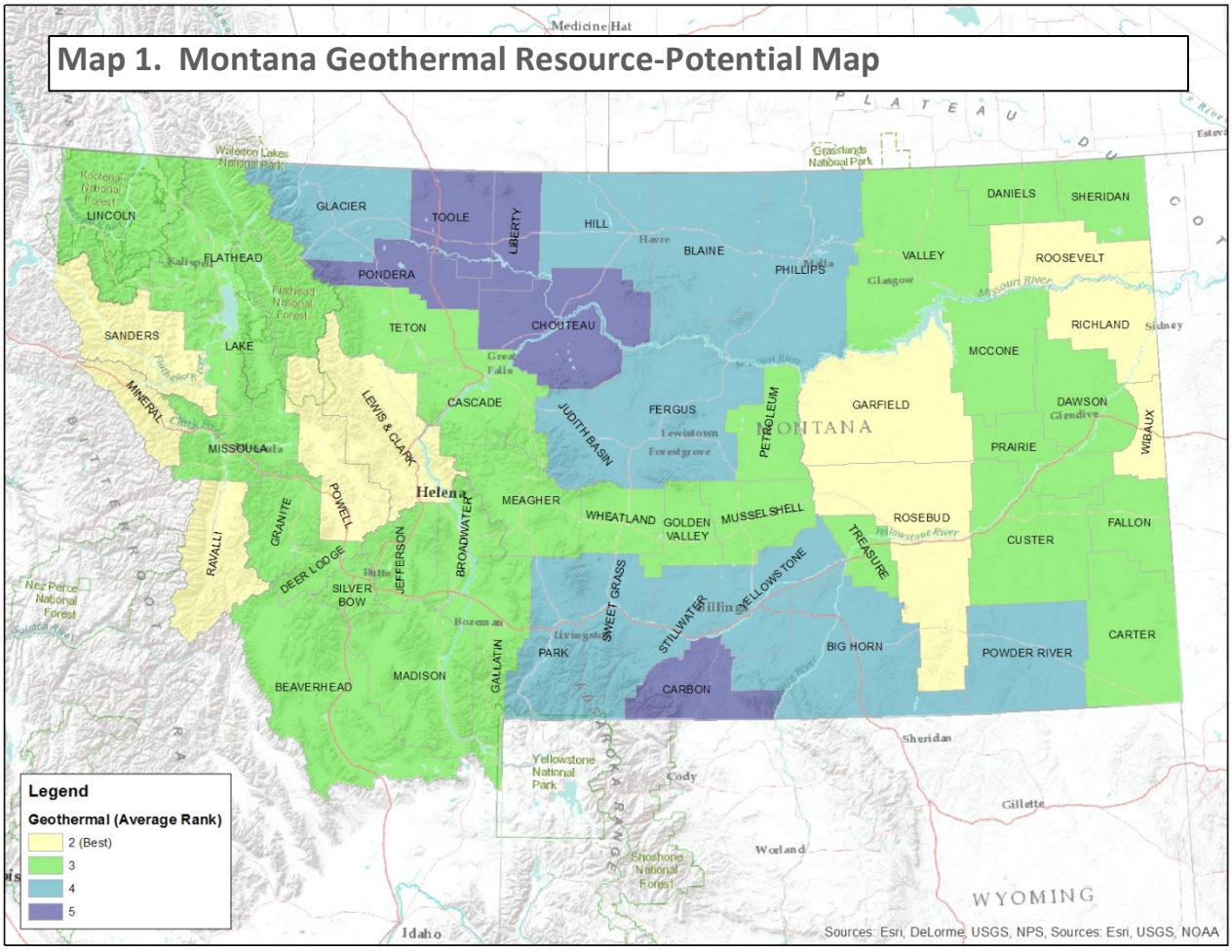
A pumped hydro storage project is in the Northwest Montana (NWMT) interconnection queue for Meagher County. This study posits it will add 400MW (600MW in queue report) of capacity by 2019.

Solar interconnects for a number of 3MW projects are in the queue for Lewis and Clark, Big Horn, Broadwater, Deer Lodge, Missoula, and Golden Valley over the next year or so. Collectively, they would add 60MW of capacity to the State's generating capacity, as early as 2016.

A number of other renewable technologies seem to be well into the stage of economic (and environmental) feasibility studies. Fourteen 'non-power' dams have been studied for hydroelectric potential, totaling nearly 70MW. This includes Gibson Dam and Clark Canyon Reservoir.

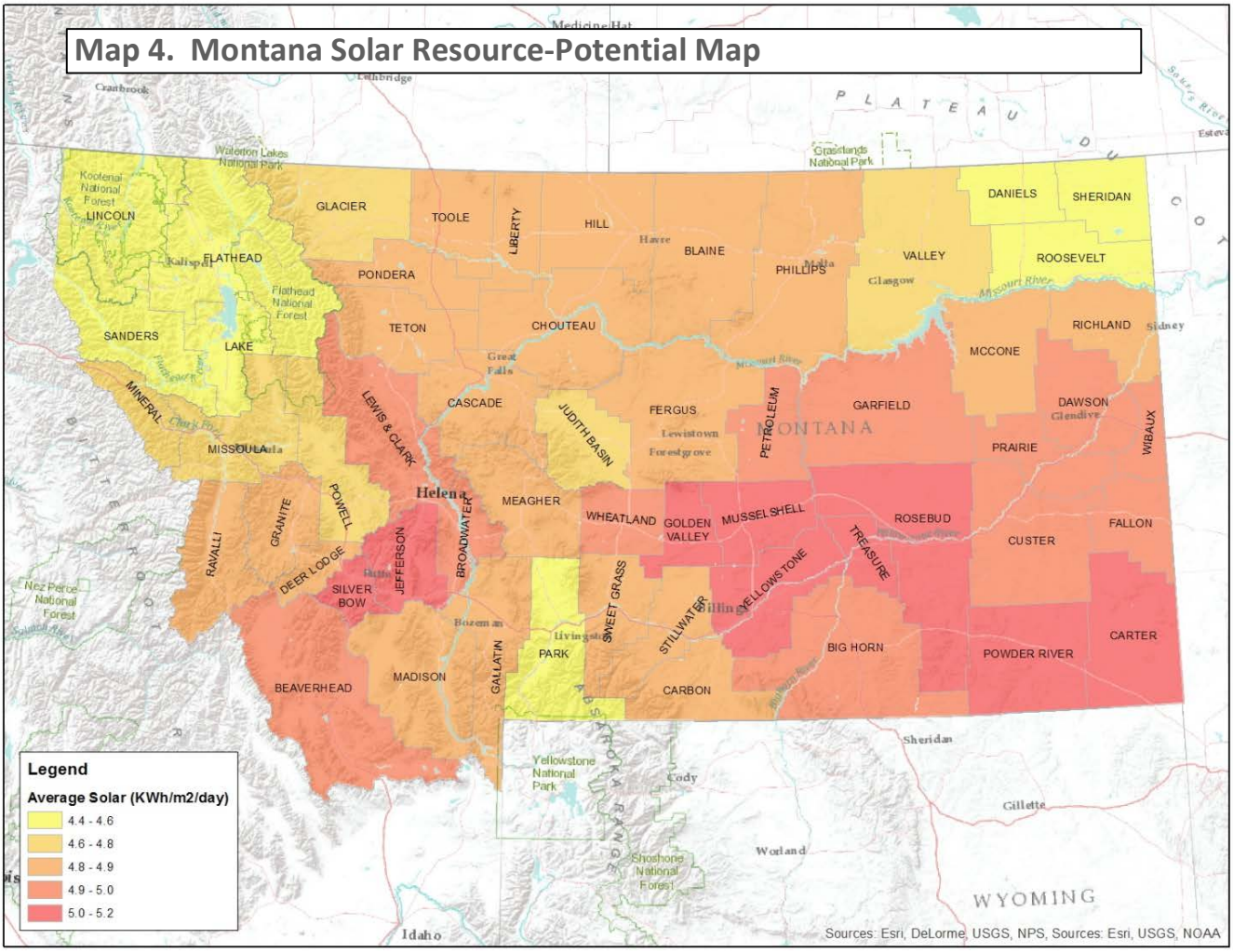
Geothermal technologies could also play a significant role in future renewable energy development, since the State has a number of geothermal sites. Their potential for electricity generation has generally been considered a longer term possibility. However, there are indications that near term prospects may be higher for tapping geothermal energy from existing gas wells[16]. This may be a potential way to generate the electricity needed to produce oil from the Bakken and Three Forks fields. Such developments may not involve a large MW number or connect to the grid but, like the role of fast acting gas plants in smoothing fluctuations in supply and demand, may be an important catalyst for change in the energy sector. Montana also has the potential to utilize geothermal energy as a resource for heating buildings including geothermal heated greenhouses.

The following map depicts county averages of resource potential for geothermal energy. However, actual development potential is likely to be less because these data do not include analyses of environmental and other siting constraints. It is based on data developed by the National Renewable Energy Laboratory ("NREL"), which is operated by the Alliance for Sustainable Energy, LLC for the U.S. Department of Energy ("DoE"). Details for the source data are available at: http://www.nrel.gov/gis/data.html

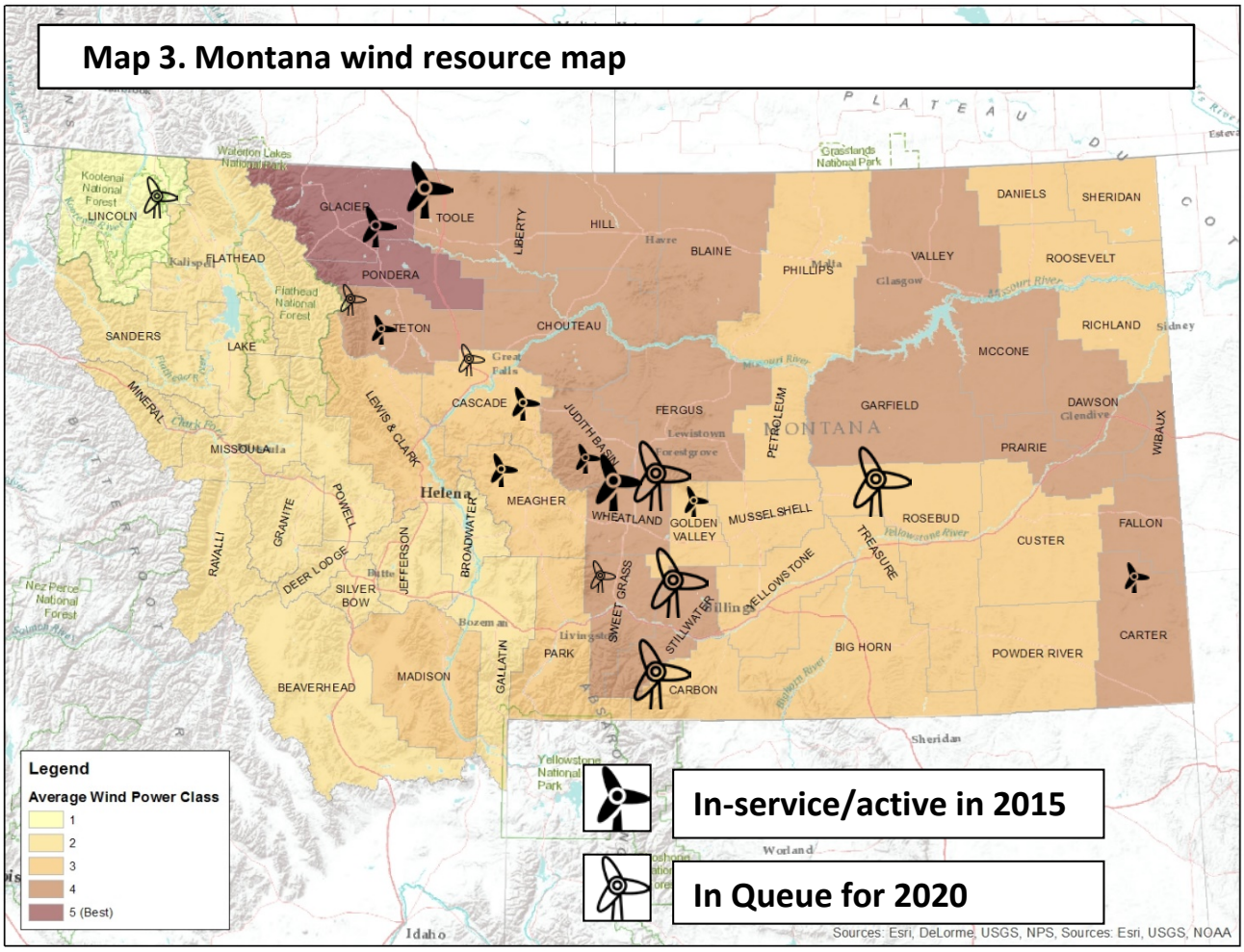


Similarly, Renewable Northwest's estimate of small scale solar generating 4MW of electricity is a small number but may signal more fundamental changes in the power system. Montana is also home to VIZn Energy from Columbia Falls Montana, which some experts believe provides a viable flow battery alternative to simple cycle gas peaking power plants. Tesla has also recently released Powerball, a new batter backup system for households that is far cheaper than previous solutions. The small MW figure for these technologies, compared to wind, should not obscure the fact that some may yet show a high return on investment—and State RPS's along with other policies (e.g. net metering) may have encouraged consideration of their possibilities. As battery backup solutions improve over time and the price of solar panels decreases, we may see a rapid rise in development of commercial and residential solar installations.

The following map depicts county averages of daily solar resource potential for photovoltaic panels. However, actual development potential is likely to be less because these data do not include analyses of environmental and other siting constraints. It is based on data developed by the National Renewable Energy Laboratory ("NREL"), which is operated by the Alliance for Sustainable Energy, LLC for the U.S. Department of Energy ("DOE"). Details for the source data are available at: http://www.nrel.gov/gis/data.html



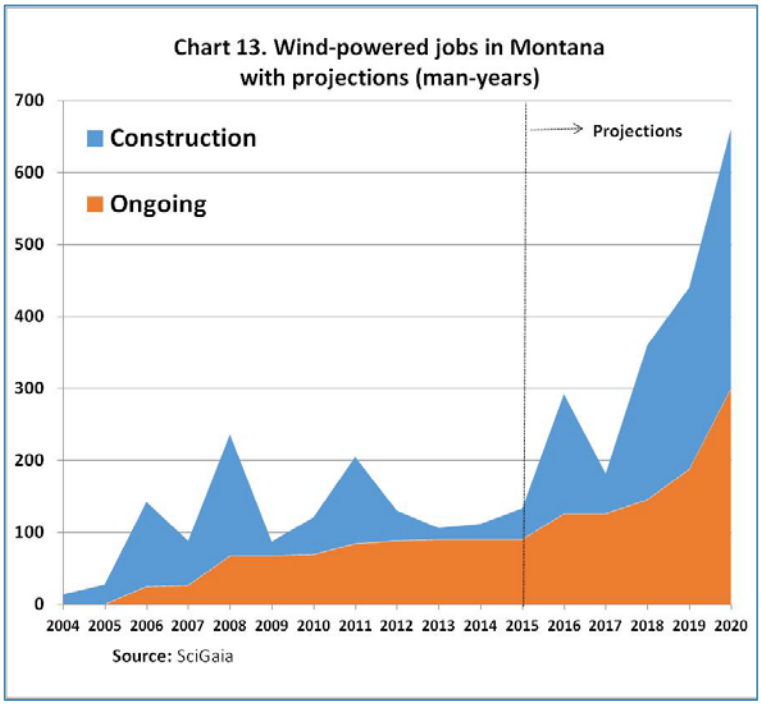
The following Montana wind map depicts County averages wind available for utility scale wind turbines. It also indicates which Counties have wind farms, in-service (solid black icons) as well as those projected Bottom-Up metrics (Open icons) discussed in this paper. (Icons are roughly scaled to show differences in MW but are not positioned to show actual locations in Counties.) It should also be emphasized that actual development potential is likely to be less because these data do not include analyses of environmental and other siting constraints beyond excluding areas of obvious land use incompatibility. Wind Power Classes are based on data developed by the National Renewable Energy Laboratory ("NREL"), which is operated by the Alliance for Sustainable Energy, LLC for the U.S. Department of Energy ("DOE"). Details for the source data are available at: http://www.nrel.gov/gis/data.html

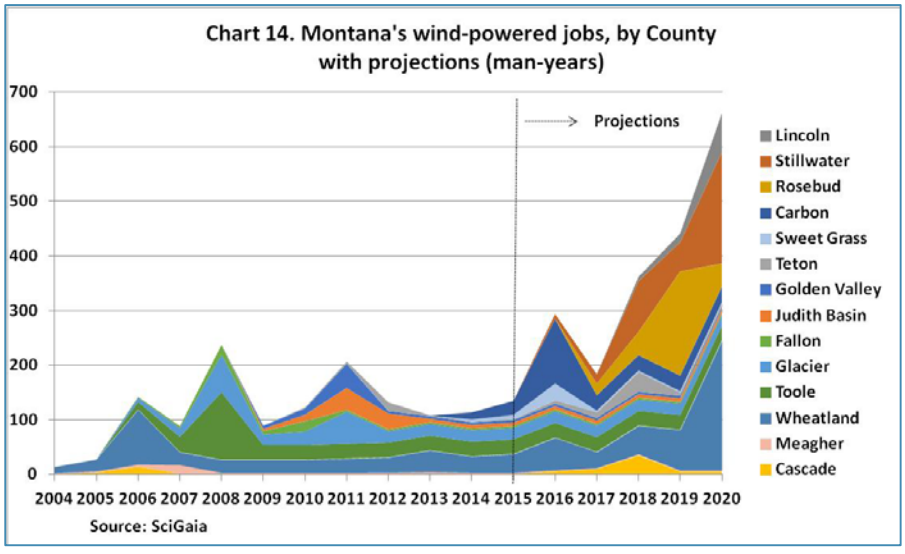


2) MONTANA WIND VISION 2020

If all renewable projects in an interconnection queue are realized by 2020, and carbon-fired generation stays as it is, the State would see generating capacity rise from about 6,800 today to over 8,800; averaging 7% growth per year. Wind generation capacity would hit 2,400MW by 2020, up from 670 today; averaging 29% growth per year. This would mean renewables, broadly defined, rise from 52% to 64% of the State's total nameplate capacity; wind alone would go from 10.4% of nameplate capacity in 2015 to 27% by 2020.

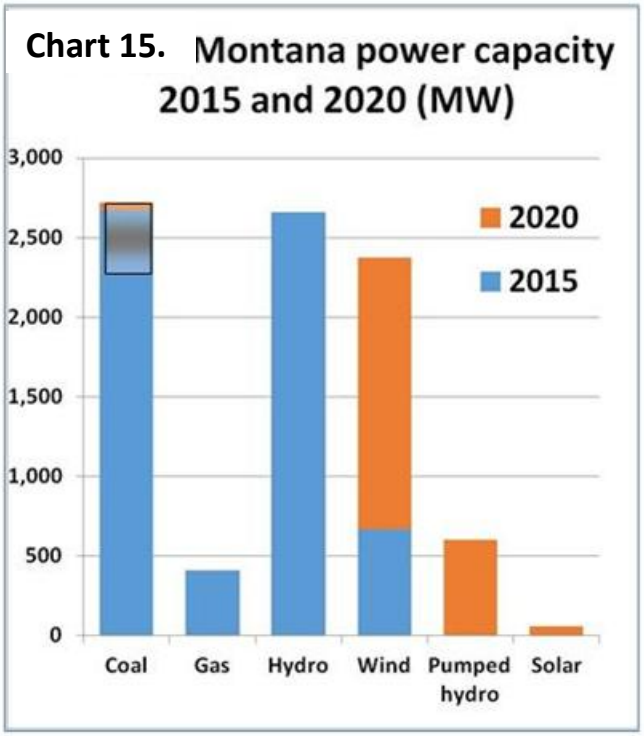
Chart 13 shows the growth in jobs to be expected with such an increase (with same trends in spending, etc.). Apart from construction, there would be about 300 wind-powered jobs in the State, with County breakdown as shown in Chart 14. Onsite spending (mainly labor) would be bringing in $14 million, while taxes and land leases would be bringing in an additional $42 million, per year.





The State's power generating portfolio would then change, from 2015 to 2020, as shown in Chart 15. Wind would be about as important as conventional hydro; pumped hydro would be more important than natural gas. Solar would be minor but in the game. The unlikely increase charted for coal-fired power (a pending Southern Montana project in Cascade County) is overshadowed by the more likely decline as J. E. Corette (172MW) and possibly Colstrip 1 or 2 (358MW each) are retired as shown by the box on the coal column in Chart 15. The cost of wind projects will depend on whether retiring coal frees transmission capacity.

Wind power would then be adding $55 million to Gross State Product and 300 man-years to yearly employment; compared to $16 and 90, respectively, in 2015. From 2005 through 2020, wind will have created 3300 man-years of work in Montana. Half will have been construction jobs and the other half split about evenly between onsite labor and indirect effects or stimulus to the local economies.



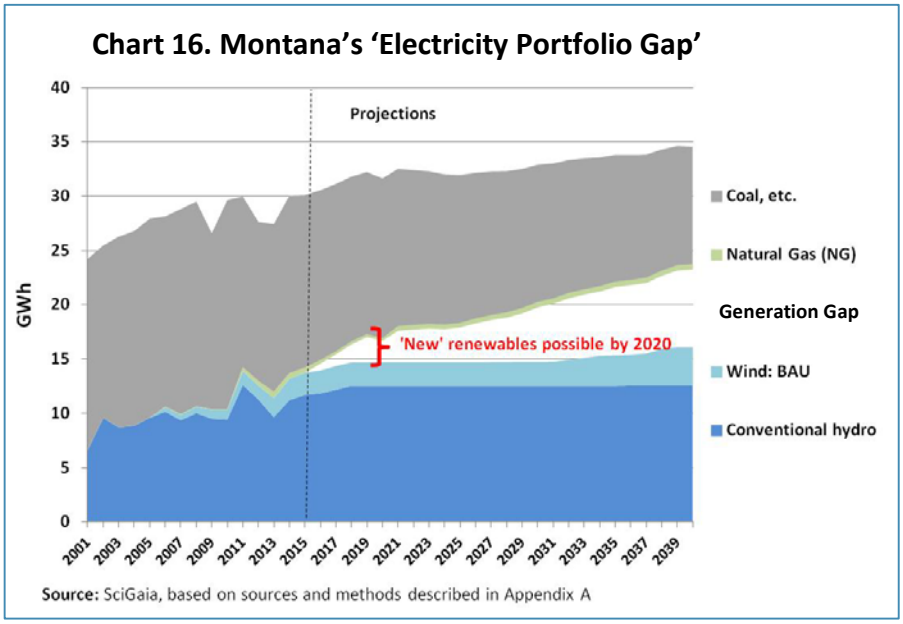
3) GENERATION GAP

Yesterday's electricity system was designed to transmit dispatchable power from centralized (mainly coal-fired) plants on one-way trips to consumers—mainly clustered in towns and cities. It did so with great efficiency and reliability; particularly after localized systems were interconnected. Tomorrow's system will have to further mix dispatchable with intermittent or natural (water, wind, solar) power sources; and centralized with decentralized generation. National entities like the North American Electric Reliability Corporation (NERC) and DoE (and specifically NREL) as well as regional entities like WECC and the Northwest Power Pool (NWPP) are actively considering system redesign. A more quantitative approach may help policy-makers at the State level decide whether, and if so how, their policies and incentives help or hinder the redesign process.

For example, DoE (AEO2015) does not offer projections that consider effects of the Environmental Protection Agency (EPA's) CPP, but CPP starts with DoE data and posits changes in the national pollution-to-power ratio. This is translated into State targets. States are left to devise decide how to meet targets, with EPA suggesting three ways:

- Make coal-fired plants more efficient,
- Increase use of existing natural gas plants, and
- Rely more on renewables. [17]

As the Montana Department of Environmental Quality's white paper "Options for Montana's Energy Future" makes clear, there are potential strategies to meeting EPA's proposed CPP carbon regulations without retiring or curtailing coal generation in the state. However, all likely require exceptional ingenuity, cooperation, and a proactive policy approach to deploying clean energy technologies. If policymakers and industry are unable to work



cooperatively to engineer solutions, CPP targets for the State's pollution-to-power ratio might only be met by relying less on coal. Chart 16 shows how much less by applying the targeted ratio to power generation projection from Part A. Adding up supply side numbers then leaves a generation gap, representing potential lost economic energy activity to the state of Montana. The bracket in the chart indicates that, even in this scenario, renewable projects could fill the gap to 2020 if most are in-service by then.

There may be other ways and means to close the gap between demand for Montana's energy and what the State can expect to supply if and when the Clean Power Plan (CPP) is implemented. Most States, including buyers of bulk power from Montana, face similar or larger gaps. Lead time for energy infrastructure means CPP targets for 2020 have to be met with what is in hand or at least on the drawing board, now. This means Montana has a comparative advantage, given renewable energy on its drawing board, and decisions by the State could catalyze that. However, most ways and means require collaboration with other 'stakeholders,' notably managing uncertainties and risks in repurposing the interconnected electricity grid from one way flows of dispatchable power to two-way flows including intermittent prime movers like wind and solar. All these are Policy Zone issues.

V. REFERENCES

Some of the following references will be available for download from the sciGaia website by June 1, 2015 at the following URL:

www.sciGaia.com/renewablesRPS

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[1] Page 186 of 394, BiennialReport-2012-2014.pdf

[2] See Department of Energy report on nation-level 'pause' in wind projects due to uncertainties about the Federal Production Tax Credit. Also, see Senate Rejects Wind PTC Extension, March 2015.

[3] *Review and Status of Wind Integration and Transmission in the United States: Key Issues and Lessons Learned*, Milligan, et al; March 2015, Page 2.

[4] Montana also has some reserves and production of oil and natural gas, not considered in this paper except to estimate fossil fuel reserves in Chart 3.

[5] EIA data [epa_03_14.xlsx] show Montana's independent power producers produced 1.161 GWh of renewable electricity in 2012, compared to 101 GWh from its Electric Utilities.

[6] Electric_Power_Projections_by_Electricity_Market_Module_Region.xlsx

[7] State policies and financial incentives for renewables, efficiency, and demand side management are detailed at DSIRE. The timeline of initial RPS is SciGaia's repackaging of DSIRE reports as detailed in DSIRE.xlsx.

[8] For details, see *A Look at the Impact of Montana' Renewable Energy Standard*, an ETIC report to 64th Montana Legislature.

[9] In particular, benefits in terms of jobs and investment were assessed in A Detailed Look at the Impacts of Montana's Renewable Portfolio Standard, Energy and Telecommunications Interim Committee of the Montana Legislature report to the 64th Legislature, September 2014; and Employment Effects of Clean Energy Investments in Montana, Synapse Energy Economics' report for the Montana Environmental Information Center & Sierra Club, June 2014. This study applies the NREL JEDI model, used in those earlier studies, to latest information about power plants connected to the grid or with a high probability of connection by 2020 (see Appendix ? for more detail).

[10] JEDI cites IMPLAN as its authority for input-output coefficients for wind and solar projects.

[11] See, for example, NREL's Potential Reliability Impacts of EPA's Proposed Clean Power Plan - Phase I.pdf; page 46 of 69.

[12] BiennialReport-2012-2014.pdf, page 186 of 394. Comprises $857 million listed as assessed value of wind generation properties plus $124 for assessed value of renewable mileage. Technically, the comparison should recognize that Electric Companies also have assessed value in mileage ($173 million) and some of this is in towns/cities ($14 million).

[13] Page 186 of 394, BiennialReport-2012-2014.pdf

[14] There are some discrepancies between assignment of County in this chart, which is based on interconnection, and County of property assessment. These do not affect this point.

[15] In Montana: NWMT, BPA, MISO

[16] DOE sponsored research on low temperature geothermal energy: http://energy.gov/eere/geothermal/downloads/electric-power-generation-coproduced-fluids-oil-and-gas-wells

[17] This paragraph is based on EPA Administrator McCabe's blog at http://blog.epa.gov/epaconnect/2014/06/understanding-state-goals-under-the-clean-power-plan/. However, energy efficiency is not listed here since it doesn't affect the emission rate of the power sector (carbon/MWh).