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## 1 INTRODUCTION

Growing demand for electricity and Renewable Portfolio Standards (RPS) in the western US are creating unprecedented demand for power generated from renewable resources. Wind energy, in particular, is targeted for large scale development. Montana has the most total wind generation potential in the West, and additionally, ranks second only to Wyoming with respect to high Class wind resources. Montana's wind profile peaks during winter months, which makes it advantageous to utilities in the Pacific Northwest, whose systems peak during these months. Furthermore, the average capacity factor for Montana wind generation generally increases steadily during "on-peak" hours of the day, another quality that makes Montana's wind generation resources desirable to potential utility buyers.

The two primary obstacles to further utility-scale development of wind resources in Montana are integration costs and transmission barriers. There are currently five major transmission projects planned that would significantly increase the state's capacity to export wind energy, including the Montana Alberta Tie Line, the Mountain States Transmission Intertie, the Chinook Transmission Project, and the Colstrip Upgrade. If all four of these projects were built as planned, Montana would have approximately 5,400 MW of additional transmission capacity. In addition, should the Grasslands Project mature to full development, it would increase the transmission capability out of the state by another 1,000 MW.

Integration costs are also seen as an impediment to more wind development nationwide. These costs vary regionally based on a utility's generation portfolio and other factors which can make wind energy economically more risky to develop. Preliminary results of the Western Wind and Solar Integration Study show that there is potential for these risks to be somewhat mitigated through geographic diversity and aggregation strategies.

This report evaluates the relative competitive position of wind energy from Montana compared to the wind resources from other western states. The Western Renewable Energy Zones (WREZ) model was utilized for the analysis. The results of the study show that Montana wind is most competitive in markets with a closer proximity to the state such as those in the Pacific Northwest yet remains a potential competitive resource in markets geographically further removed

## 2 DEMAND FOR RENEWABLE ENERGY

Demand for Montana's wind energy will be created by both a growing demand for electricity and a growing demand for renewable energy created by Renewable Portfolio Standards (RPS) in the western US. These standards generally require utilities to procure a certain amount of energy from renewable sources. Presently, 29 states as well as Washington, DC, have enacted a RPS, while five other states have set non-binding RPS goals. Utilities can typically comply with their RPS either by building the renewable generation themselves, purchasing renewable energy credits (RECs), or by purchasing energy from an independent renewable generator. RECs are the renewable or "green" attributes associated with the generation of renewable energy. It is important to note that RECs can either come bundled or unbundled. Bundled RECs include both the renewable attributes and the generated energy, unbundled RECs, or tradable RECs (TRECs) as they are sometimes called, are comprised of the renewable attributes alone. When unbundled, one company receives the renewable credits or attributes, while another company receives the generation. For example, NorthWestern Energy, a Montana utility, currently purchases the entire output of the Judith Gap Wind Farm Project in the form of bundled RECs, receiving the green attributes along with the electrical generation from the project. Often in the West, unbundled RECs are sold by smaller independent projects. In this case, the generator will sell the electrical generation to one utility (often the local utility), and the RECs to a separate entity.

The structure of western states' RPSs, and especially how they treat out-of-state resources, will likely have a substantial impact on the potential market penetration of Montana's wind generation as well. When compared to states with larger demand for renewable energy, Montana's need for renewable generation is quite small; ***the key to large scale development of Montana wind will be the ability to economically compete in out-of-state markets. Thus, as development of the western renewable market progresses, it will be critical for Montana developers, regulators and policymakers to stay abreast of these standards across the Western region.***

### 2.1 FORECASTED DEMAND FOR ENERGY

Table 2.1 below shows the historical and forecasted electricity sales in GWh for each state within the western US. The data indicates that there is substantial forecasted load growth across the entire West, with exceptional growth expected to occur in the Desert

Southwest region (Arizona, Southern California and Southern Nevada) and the Pacific Northwest (Northern California, Oregon and Washington). Montana and Wyoming respectively have a much smaller projected need for electricity. Given the growing demand for renewables in the western region, a substantial percentage of the projected load growth shown in the table is anticipated to be met by the renewable energy sources. The table gives a snapshot of where the load growth will be most prominent. Montana wind, to be successful in filling market demand, will need to be primarily targeted for delivery to key load growth areas.

**Table 2.1<sup>1</sup>**

<b>Historic &amp; Forecasted Electricity Sales (GWh)</b>						
	<b>2007</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>
<b>AZ</b>	77,193	90,103	105,337	121,167	138,097	156,589
<b>CA</b>	264,235	278,599	297,359	315,018	335,014	356,343
<b>CO</b>	51,299	51,933	57,148	63,160	69,386	76,316
<b>ID</b>	23,755	24,995	26,357	27,980	30,017	32,138
<b>MT</b>	15,532	15,020	15,599	16,185	16,789	17,433
<b>NM</b>	22,267	23,877	26,291	28,914	31,991	35,694
<b>NV</b>	35,643	37,128	41,421	45,376	48,857	53,138
<b>OR</b>	48,697	50,681	55,315	60,393	65,927	72,014
<b>UT</b>	27,785	29,520	33,399	37,127	40,194	43,514
<b>WA</b>	85,742	90,076	95,699	103,898	114,337	124,169
<b>WY</b>	15,536	17,389	20,553	22,995	23,694	24,413
<b>TOTAL</b>	<b>667,685</b>	<b>709,320</b>	<b>774,478</b>	<b>842,213</b>	<b>914,303</b>	<b>991,761</b>

## 2.2 RENEWABLE PORTFOLIO STANDARDS AND RENEWABLE ENERGY CREDITS

The second component contributing to the projected increase in demand for renewable energy is the adoption of RPSs by most states in the western US. Not only will western states require more generation to meet load forecasts (as indicated in Table 2.1), they will need a significant portion of that generation to qualify for their state’s RPS. A summary of these standards is shown below in Figure 2.1. States without an RPS, such as Wyoming and Idaho are in the minority, while only one state, Utah, has a non-mandatory RPS goal. The remaining western states all require significant portions of their future electricity sales to come from renewable sources. While the definition of

<sup>1</sup> Information gathered on a state-by-state basis from sources such as various FERC Form 1 documents, the CEC Demand Staff Forecast, and SNL Financial.

what qualifies as renewable differs slightly between the states, the renewable resources generally included are:

- Solar
- Landfill gas
- Wind
- Biomass
- Geothermal
- Municipal solid waste
- Anaerobic digestion
- Tidal energy
- Wave energy
- Ocean thermal
- Fuel cells using renewable fuels

Additionally, hydroelectric may be included if it meets the criteria in that state for a qualified hydroelectric facility. Qualified hydroelectric energy usually includes generation added to already existing hydroelectric facilities that have been upgraded, new projects under 30 MW or so-called run of the river hydroelectric energy, which doesn't physically impede the flow of the waterway.

**Figure 2.1 Renewable Portfolio Standards as a Percentage of Electricity Sales**

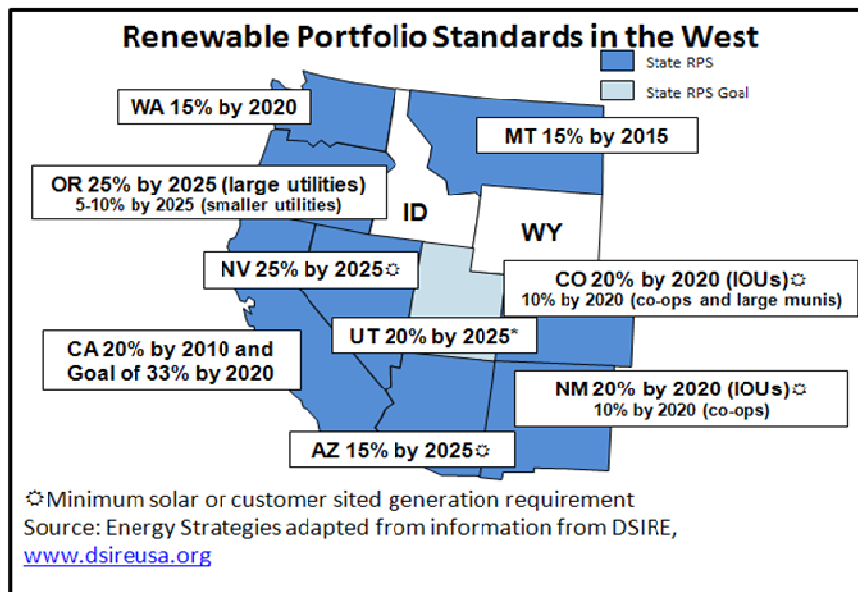
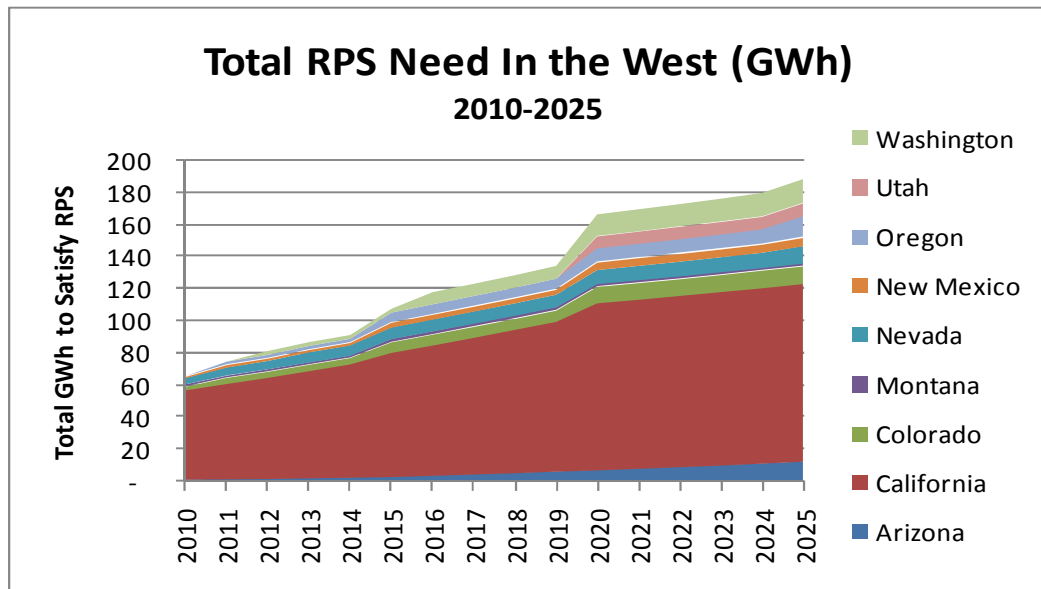


Figure 2.2 below indicates the level (GWh) of renewable energy each western state will need to meet their RPS goals between the years 2010 and 2025. While California clearly will require the most renewable resources, the other states' needs should not be discounted since significant demand for such resources exist in these states as well.

**Figure 2.2<sup>2</sup>**



Aside from the percentage of energy sales that must come from renewable sources specified in each state's RPS, the other critical item from the perspective of renewable development is how each state's RPS will treat out-of-state renewable energy. In simple terms, a critical question is whether a state's RPS allows out-of-state renewable resources to qualify towards meeting the state's renewable goal. The issue of qualifying out-of-state resources to meet in-state goals has become a contentious issue in some states, such as California, as legislators debate the benefits of keeping renewable development in their home state versus the reality of meeting ambitious renewable standards.

Currently, Utah and Oregon have standards that are the most favorable with regards to allowing out-of-state resources to count towards meeting their respective RPS requirements. These states do not have any restrictions on the use of out-of-state

<sup>2</sup> Information gathered on a state-by-state basis from sources such as various FERC Form 1 documents, the CEC Demand Staff Forecast, and SNL

renewable energy counting towards meeting the RPS goals, and both permit the use of bundled and unbundled RECs.

The Arizona, Colorado and New Mexico markets are considered somewhat less favorable than Utah and Oregon to out-of-state renewable resources. None of these states have explicit restrictions that prohibit out-of-state renewable energy from counting towards their RPS. However, Colorado provides significant incentives for new renewable generation built in-state, and New Mexico and Arizona require proof that the energy from the specific out-of-state resource can be delivered through contracted transmission paths. In mandating that transmission rights be demonstrated in order for the renewable energy to qualify for the RPS, New Mexico and Arizona have effectively banned the use of unbundled RECs for RPS credit. Colorado's RPS allows for the use of both bundled and unbundled RECs.

Washington's RPS allows renewable resources to count towards the state's RPS if they come from west of the Continental Divide. This would significantly limit the amount of wind that Montana would be able to develop specifically for use in Washington, although it will not eliminate the state entirely as a market for Montana wind generation.

Until recently, out-of-state renewable resources were essentially disqualified from counting towards Nevada's RPS. Previously the state only allowed the use of bundled and unbundled RECs if they were located in Nevada (or met other very strict requirements). However, recently-passed legislation was intended to rewrite this rule and allow out-of-state renewable resources to be used towards RPS compliance. The legislation was developed with the intent to allow more out-of-state resources to be counted towards the Nevada RPS. We expect the use of out-of-state renewable resources to be allowed once the legislation is finalized through rulemaking.

In November 2008, California's Governor Schwarzenegger issued Executive Order S-14-08 requiring all utilities to increase renewable energy sales to 33% of their total retail sales by 2020. Legislation has been passed at the state level but not signed into law by Governor Schwarzenegger that would codify the 33% requirement. Recently the Governor signed an Executive Order directing the California Air Resources Board to adopt regulations requiring that utilities meet the higher renewable energy requirement. This would give California the most aggressive RPS in the nation. Even without the increase to 33%, California's RPS creates the largest market out of all the western states for renewable energy. Currently out-of-state resources must pass California Energy Commission eligibility criteria to count towards the RPS. None of these requirements would preclude Montana wind from counting towards the RPS.

However the legislation recently passed by the California Legislature would essentially disallow out-of-state resources from counting towards the RPS. These bills are supported primarily by environmental and labor groups claiming that the legislation would foster a local green economy and produce more distributed generation in the state. The Governor is expected to veto these bills, so the debate continues on whether out-of-state resources will be able to help meet California's RPS goals. However, utility leaders from the state admit that they would have a hard time meeting a 33% RPS without utilizing out-of-state renewable resources.

In summary, demand for energy is projected to increase dramatically over the next twenty years and RPS requirements will force a portion of that demand to be met with renewable resources. Though there remains some uncertainty regarding the RPS rules that are in question in California and Nevada, currently the market for Montana wind promises to be robust due to the favorable treatment of out-of-state renewable energy within the RPSs of most western states.

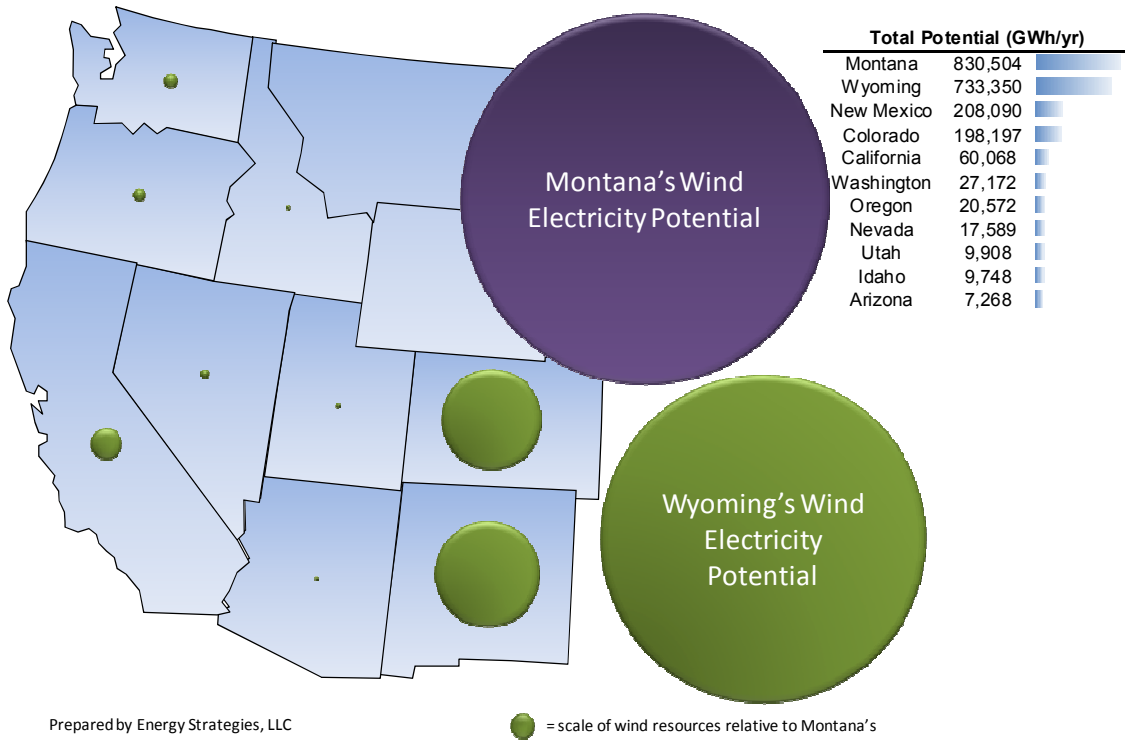
### **3 WIND ENERGY IN THE WESTERN UNITED STATES**

The discussion below evaluates Montana's wind potential vis-à-vis the wind potential from other western states. Data from the National Renewable Energy Laboratory (NREL) regarding wind potential is utilized in presenting this comparison. This data is widely considered the industry standard for comparisons of this type and has been used in several important reports such as the California Renewable Energy Transmission Initiative (RETI) Phase 1A Report.

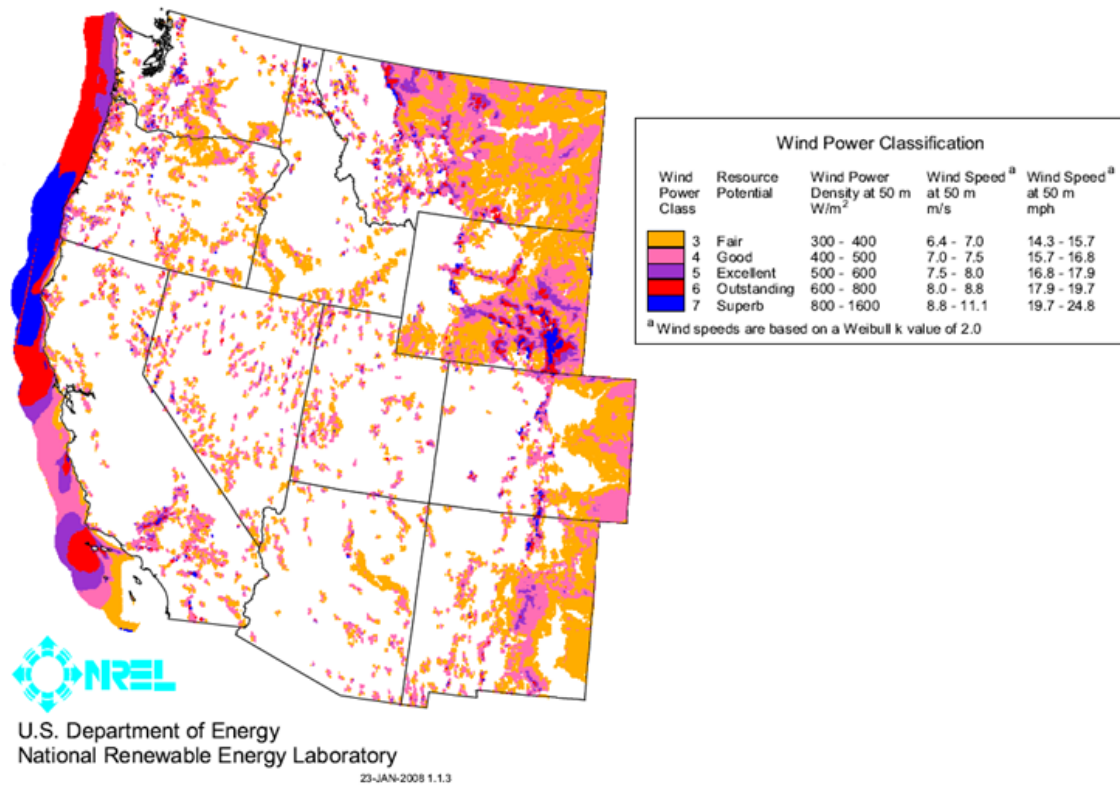
To compare the total wind energy potential between states in the western United States, wind potential data from the RETI study mentioned above was used first, and in the case of those states outside the scope of the RETI study, NREL's data set for the Wind Deployment System (Wind DS) was used. The Wind DS data was the basis for the RETI study and is an acceptable replacement in the absence of RETI data that has been updated more recently. In order to standardize both sets of data, a capacity factor of approximately 33% was used to convert the MW of Class 4 and above wind potential identified in the Wind DS data set into GWh. This methodology is consistent with that used in the RETI Phase 1A Report and allows the use of both sets of data simultaneously. Offshore wind potential was not included in this analysis.

**Figure 3.1**

**Wind Electricity Potential  
(GWh/yr) Class 4-7**



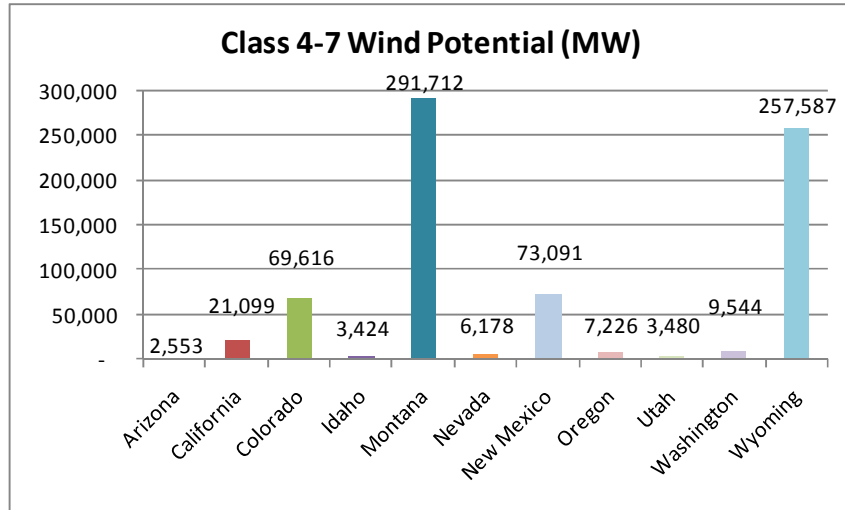
**Figure 3.2**



The above Figures 3.1 and 3.2 both clearly show that the majority of the West’s high Class onshore wind resources are found in Montana and Wyoming. Figure 3.1 is a graphical representation of the NREL and Wind DS data and shows the scale by which total Montana and Wyoming wind resources dwarf that of other states. Following that, Figure 3.2 is a wind map indicating wind generation potential by Class and also representing the abundance of high Class wind resources in both Wyoming and Montana. Montana alone contains 39% of the region’s total wind energy potential, approximately 830,500 GWh, more than all of the other western states, excluding Wyoming, combined.

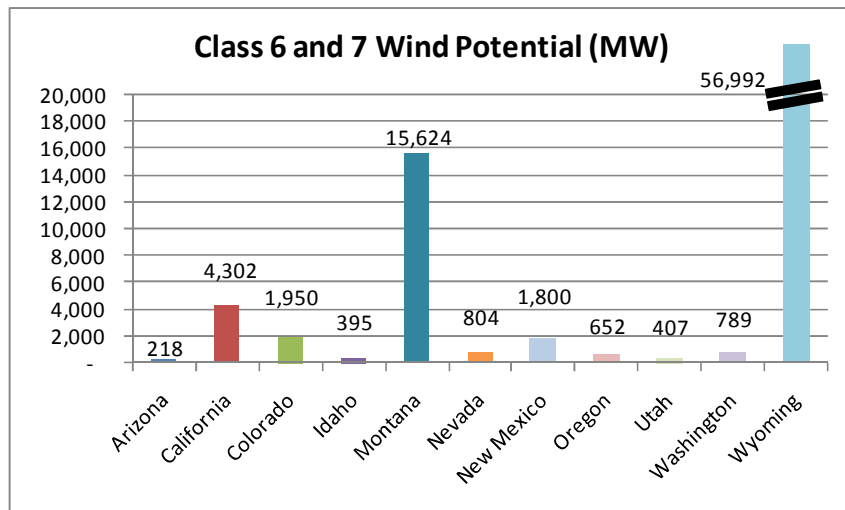
Montana not only possesses a large amount of wind resources but such resources are also of high quality. High quality wind energy is generally defined as Class 6 or 7 wind, on a scale of 1 to 7 based on the average speed of the wind. This metric is important, as it is generally these higher Class sites that will be developed first. Figure 3.3 and Figure 3.4 below show the difference between Class 4-7 wind capacity in the West and Class 6-7 wind capacity in the West.

**Figure 3.3**



Source: Energy Strategies developed from NREL and Wind DS dataset

**Figure 3.4**



Source: Energy Strategies developed from NREL and Wind DS dataset

Once again, Montana has the highest potential wind capacity of all the western states when Class 4-7 total wind potential is compared. Furthermore, Montana only falls short of Wyoming when Class 6 and 7 potential wind capacity is compared. The state has the second highest level of potential Class 6 and 7 wind capacity at 15,624 MW.

Additionally, Montana’s wind generation can be compared to that of its neighbors in the western U.S. by contrasting the average capacity factors of wind from these states. This provides a comparative snapshot predicated on average capacity factor values. The

NREL data used to generate average capacity factors are from the Western Wind and Solar Integration Study and represents a random sample of sites from NREL that are viewed as being strong candidates for a wind project. While not an exact representation of potential capacity factors in Montana, the NREL data can describe a likely scenario for wind generation in each of the western states or, perhaps most important, give an idea of relative differences between wind resources of different states. It is the relative difference in capacity factors that will be large determinant of which resources are developed first in meeting the renewable demand among western states.

In order to develop a capacity factor representative of the wind resource of each of the western states, Energy Strategies utilized the P80 value for each of the sets of state data. In other words, within the NREL database only 20% of grid points in that state have a higher capacity factor. This method accounts for the fact that the best wind sites with the highest capacity factor will usually be developed first.

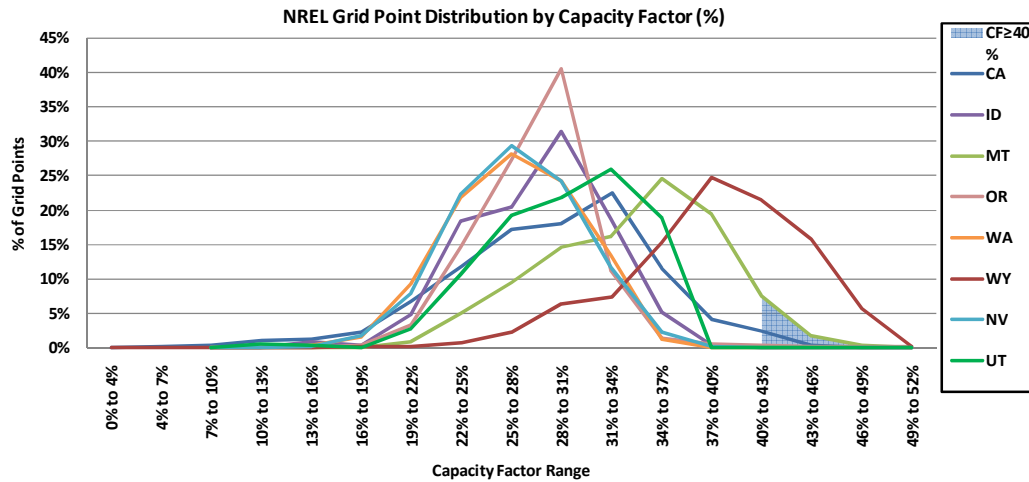
**Table 3.1**

	<b>P80 Capacity Factor</b>
<b>WY</b>	43%
<b>MT</b>	38%
<b>UT</b>	34%
<b>CA</b>	34%
<b>ID</b>	31%
<b>OR</b>	30%
<b>NV</b>	30%
<b>WA</b>	30%

Source: Energy Strategies developed from NREL Wind Mesomodel Dataset

As seen above in Table 3.1, using this capacity factor metric and the NREL data set, Montana ranks second only to Wyoming when measured this way. In other words, Montana’s average best resources are better than the rest of the western states with the exception of Wyoming. This information was also used to create Figure 3.5 below which shows the distribution of all of the NREL data points by state, not just the P80 sites. The shaded blue region of the graph represents the portion of the Montana sites that have a capacity factor greater than 40%. Again, aside from Wyoming, Montana has the greatest amount of these high quality wind sites.

**Figure 3.5**



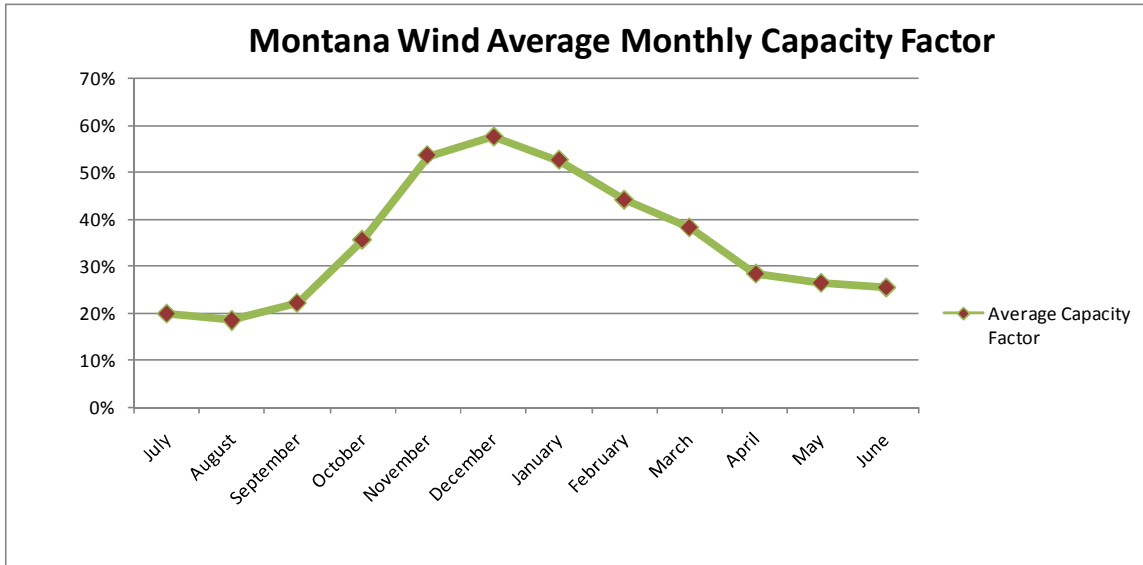
Source: Energy Strategies, adapted from NREL 3Tier Wind Mesomodel Dataset

### 3.1 MONTANA’S WIND PROFILE

Analysis for this section was done using the aforementioned NREL data by taking a sample of ten Montana wind sites from areas with high concentration of high Class wind sites and averaging their capacity factors from the past three years of available data. Again, it should be noted here that the NREL wind data does not encompass all of Montana’s potential wind sites, but provides a reasonable representation of the wind in the state. The ten sample sites utilized from the NREL wind data set were chosen because they were high-Class wind sites located in areas of high density wind.

First, as seen below in Figure 3.6, on an average monthly basis, Montana’s capacity factor is highest during the winter months. On a monthly basis, utilities in the Pacific Northwest experience their highest levels of demand during the winter when more generation is needed for heating purposes. Montana wind could be a desirable product for these utilities as their monthly peak demand coincides with when the wind is blowing at the highest levels in Montana.

**Figure 3.6**



Moreover, analysis of the same data set for the sample Montana wind sites shows that the average capacity factor of Montana wind increases from 33% in the early morning hours, to a capacity factor of nearly 38% in the late evening. Utilities see their highest levels of demand during the day, otherwise known as on-peak hours, and Montana’s average capacity factor is steadily increasing to its highest level during these hours.

To summarize, Montana has the greatest wind resource potential in the western United States when all Classes of wind are counted. Montana also possesses large amounts of high quality wind energy (high capacity factor). When only Class 6 and 7 wind resources are compared, Montana is second only to Wyoming in terms of this quality resource. Additionally, if the top 20% of average capacity factors are compared in all the western states, Montana’s P80 average wind capacity factor is 38%, or second among these states. And finally, Montana wind’s monthly and hourly peaks will be an advantage to utilities, especially those utilities seeking to match additional generation with their system demand peaks. Montana is home to some of the best wind resources in the West and, with such a robust resource, is expected to play a large role in helping other western states meet their RPS requirements.

#### **4 PROPOSED TRANSMISSION PROJECTS**

In light of Montana’s vast amounts of high quality wind energy, there is expected to be a strong market for Montana’s wind energy. It is critical, therefore, that adequate transmission capacity be available to move this power to key markets. Currently,

however, it is increasingly difficult to buy existing transmission capacity to move resources across the western grid to major market points. The western transmission grid is, for the most part, fully utilized and to meet the increasing demand for new power, particularly renewable power that is remotely located from load pockets, will require substantial new investment. The 2004 Rocky Mountain Area Transmission Study and the 2006 Clean and Diversified Energy Advisory Committee, both major West-wide transmission studies, reached the same conclusion: major investment in transmission is necessary to meet the increasing transmission requirements of the western United States. This is critical in determining the level of success Montana renewable resources will achieve in market penetration. While it has been indicated above that the state has economically attractive resources with relatively high capacity factors and that among the western states' demand for such resources is expanding, it is the ability to move these resources that will likely dictate the success Montana wind will experience.

There are currently five major planned transmission projects that, if built, will export significant quantities of wind energy from Montana. Many of these projects could be online in the near future, for instance, the Montana Alberta Tie Line could be online as soon as 2011. The other projects include the Chinook Transmission Project, the Mountain States Transmission Intertie, and the Colstrip Upgrade. Also planned for Montana but not discussed in further detail below is the Wind Spirit Project proposed by Grasslands Renewable Energy. The project is primarily designed to collect and integrate geographically dispersed wind energy in Montana, Alberta, Saskatchewan and North Dakota although three of the planned segments of the project would offer export capacity. These three lines would be 625 miles in total length and cost approximately \$1.36 billion. In total, the Wind Spirit project would connect up to 3000 MW of wind energy, then firm it with one or more energy storage applications, and have the ability to deliver approximately 1,000 MW of consistent power to regional markets. The project's developers have set a target date of 2017 for full build out and completion of the Wind Spirit project. In addition, NorthWestern Energy is developing the Energy Collector Project that as currently planned would consist of up to five collector lines that would run from some of the state's wind-rich regions and transport wind energy to a new 500kV substation at Townsend, Montana.

#### **4.1 CHINOOK TRANSMISSION PROJECT**

The Chinook transmission project is half of the joint Chinook and Zephyr proposed projects formerly known as the Inland Projects. Chinook will originate in Harlowton, Montana, and Zephyr in Medicine Bow, Wyoming with both lines terminating in the El

Dorado Valley near Las Vegas. Each line is expected to be a 3,000 MW DC line and each will cost approximately three billion dollars.

Chinook is being developed by TransCanada and two additional anchor tenants. Chinook is a unique project for Montana as it is the only proposed transmission line that would directly link the load center of the Desert Southwest with Montana. The Federal Energy Regulatory Commission issued an order allowing both lines negotiated rate authority on February 19, 2009, a significant step in the progress of both projects. Chinook is also currently in the midst of its WECC Phase 1 Rating Process and its Bureau of Land Management (BLM) application process. An Open Season that started on October 13, 2009 is being held to sell the remaining capacity. Additionally, according to the project’s developers, the Chinook line will utilize “HVDC technology that provides the lowest delivered costs for new major wind generators in Montana to the Southwest U.S. and allows customers to avoid paying “pancaked” utility rates. HVDC also minimizes transmission losses and its control technology allows wind to be directly scheduled, in real time, to load centers in the Southwest, thereby minimizing ancillary services issues.”

Chinook Project	
Developer(s)	TransCanada and two anchor tenants
Path	Harlowton, Montana to the El Dorado Valley (near Las Vegas).
Expected Rating	3,000 MW
AC/DC	DC
Length	1,000 miles
Estimated Cost	\$3 billion
Online Date	2014
Development Status	WECC Phase I Rating Process. Permitting in early stages with preliminary application submitted to BLM. Recently received FERC approval for negotiated rate authority. Precedent “anchor tenant” concept approved by FERC. Open Season for the remaining capacity started on October 13, 2009.

## 4.2 MOUNTAIN STATES TRANSMISSION INTERTIE

The Mountain States Transmission Intertie (MSTI) Project is a proposed project that would run from a new substation near Townsend in western Montana to the Midpoint substation near Twin Falls in southern Idaho. The line would be approximately 430 miles long and is currently proposed as a 500 kV, AC transmission line with roughly 1,500 MW of capacity.

MSTI is being developed by NorthWestern Energy, a publicly traded utility that provides electricity and natural gas to over 650,000 customers in Montana, South Dakota and Nebraska. The company has already held a preliminary Open Season to determine interest in the line, and plans on initiating a new Open Season in the spring of 2010. The project developers have already completed the WECC Phase 1 rating process, and are nearing completion on Phase II and anticipate WECC approval in early 2010. A draft Environmental Impact Statement (EIS) is expected to be released the first quarter of 2010, the final EIS is expected to be completed by the third quarter 2010, and the Record of Decision obtained in the fourth quarter 2010. The Federal approval process in Idaho is expected in approximately the same timeframe. Recently the FERC turned down MSTI's application for market-based rates, but stated that MSTI could proceed on a cost of service basis by requesting appropriate tariff waivers to NorthWestern's existing OATT. NorthWestern Energy has stated publicly that they will proceed with planned development activities and the aforementioned Open Season.

One benefit of MSTI is to relieve existing congestion between Montana and Idaho thereby allowing significant amounts of renewable power to be moved to Midpoint where access to regional markets is possible through existing and proposed new transmission lines. This congestion is a potential barrier to entry for prospective renewable energy development in Montana and the MSTI Project would have the potential to ease the congestion problems in the area.

<b>Mountain States Transmission Intertie (MSTI)</b>	
Developer(s)	NorthWestern Energy
Path	Proposed Townsend substation (western Montana) to Midpoint substation near Twin Falls (southern Idaho).
Expected Rating	1,500 MW
AC/DC	AC 500 kV
Length	430 miles
Estimated Cost	\$1B
Online Date	2015
Development Status	New Open Season in the spring of 2010. Completed the WECC Phase 1 rating process, nearing completion on Phase II and anticipate WECC approval in early 2010. A draft Environmental Impact Statement (EIS) is expected to be released the first quarter of 2010, the final EIS is expected to be completed by the third quarter 2010, and the Record of Decision obtained in the fourth quarter 2010.

### 4.3 MONTANA ALBERTA TIE LINE

The Montana Alberta Tie Ltd. Transmission line (MATL) is a project being developed by Toronto-based Tonbridge Power Inc. The project will be a 300 MW 230-kV line running from a new substation near Lethbridge, Alberta to NorthWestern Energy’s Great Falls substation near Great Falls, Montana and allow the movement of power between Alberta and Montana.

The MATL developers received the last permit necessary to initiate the construction phase of the project on November 17, 2008. Construction began in the fall of 2009 and the line is expected to be in service in 2011. In September of 2009, the MATL project received \$161 million in funding from the Western Area Power Administration (WAPA) to help build the project. WAPA will be using borrowing authority granted under the American Recovery and Reinvestment Act (ARRA) to finance the project. The MATL project is the first project to receive funding from WAPA through the ARRA.

Capacity provided by the MATL line is expected to be in high demand as capacity between Alberta and Montana is in short supply. The project will fill that void and also “reinforce the reliability of the continental transmission grid,” according to the project’s developers. The entire project will serve the wind energy in Montana, as “Montana-based wind energy projects have contracted full capacity on the line,” also according to the MATL developers.

<b>Montana Alberta Tie Ltd. (MATL)</b>	
Developer(s)	Tonbridge Power Inc.
Path	Lethbridge, Alberta to Great Falls, Montana
Expected Rating	300 MW
AC/DC	AC 230 kV
Length	214 miles
Estimated Cost	\$200 million
Online Date	2011
Development Status	The MATL project received the U.S. Department of Energy’s presidential permit on November 17, 2008; this permit was the final step in the permitting and regulatory process that the project’s developer, Tonbridge Power, Inc. needed to begin construction. Construction on the project began in the fall of 2009.

#### **4.4 COLSTRIP UPGRADE**

The Colstrip Upgrade is a project currently under review by NorthWestern Energy, Avista Corporation, Puget Sound Energy, Portland General Electric, PacifiCorp, and the Bonneville Power Administration (BPA). The project would upgrade the capability of the two existing 500-kV transmission lines that traverse Montana. The starting point for the upgrade has not been determined, but it could start as far east as Colstrip, with other starting points being Broadview or Townsend. The starting point for the upgrade would depend on requests for transmission service to accommodate new renewable energy

generation. As proposed, the project would primarily ship renewable energy across Montana to the Pacific Northwest, where the state’s wind power could provide added geographic diversity to the generation portfolios of utilities in the Pacific Northwest.

The utilities developing the Colstrip Upgrade have completed a study of potential transmission upgrade alternatives, and are working on potential ownership structures, and financing options; any final ownership structure will be determined once participating projects are identified and all participating utilities agree to the projects.

As currently planned, the upgrade will not add additional length or segments to the existing line, but rather increase the path capability by approximately 600 MW, and cost approximately \$210 million. The permitting and approval process is generally easier and less time consuming for upgrades that do not need new right-of-way as opposed to new transmission projects. This is due to the fact that upgrades typically have fewer regulatory and permitting barriers to contend with. It is anticipated that the upgrades on the Colstrip Transmission System will be done in 2012 and on BPA’s Transmission System in 2013.

<b>Colstrip Upgrade</b>	
Developer(s)	NorthWestern Energy, Avista, Puget Sound Energy , Portland General Electric, PacifiCorp and BPA
Path	Colstrip to Townsend and the BPA system
Expected Rating	Increase the path rating by 600 MW
AC/DC	AC
Length	No length added
Estimated Cost	\$210 million
Online Date	2012 on Colstrip Transmission System and 2013 on the BPA Transmission System.
Development Status	The utility partnership is currently conducting ongoing feasibility studies to determine possible financing arrangements, gauging interest in the upgrade, and evaluating transmission alternatives that would achieve the same objectives as the upgrade.

## 5 WIND INTEGRATION COSTS

Aside from the lack of available transmission capacity, the other prime concern to wind generators is integration charges. Wind is an intermittent resource, thus its placement on the transmission grid is periodic. Wind resources are a valuable component of a utility's resource portfolio, but due to the variable nature of the wind resource it has little ability to meet base load generation on their own without firming resources. Lacking thermal generation as a firming resource, wind energy essentially increases generation variability and uncertainty for balancing authorities that are in charge of instantly matching loads needs with generation output. This additional variability and uncertainty subsequently increase the demand for regulating reserves and load-following reserves, additional on-call resources that are intended to balance the minute-to-minute and hourly changes within the system. The primary driver of wind integration costs is the cost of securing these additional reserves. Other contributors to wind integration costs may include additional operation and maintenance charges related to the additional use of the hydroelectric or natural gas facility providing the reserves, and efficiency losses due to the additional cycling of either type of facility.

Integration costs are expected to vary greatly from region to region because of the differences in wind resources as well as the resources used for firming. The uncertainty surrounding integration costs has served as a deterrent to the economics of wind development and, thereby, created a risk to utilities and developers. For example, a region with wind resources that blow at a consistent rate will likely experience lower wind integration costs than a region with more variable wind resources.

An important entity currently studying issues related to variable generation in the West is the Western Electric Coordinating Council (WECC) Variable Generation Subcommittee (VGS). The VGS received their charter from WECC on October 21, 2008 and was charged with "identifying issues and opportunities related to the presence of variable generation sources in the Western Interconnection and facilitate the development and implementation of solutions that add distinct value to WECC members." The charter also states that "The VGS will focus on regional reliability and market challenges of renewable energy integration and other emerging issues as requested by the (WECC) Joint Guidance Committee." Since the VGS was formed, the group has created four subgroups: marketing, operating, technology and planning. Additionally, a work plan charting the proposed actions of the group over the next two years has been composed, and a comprehensive assessment of previous work and ongoing studies that have been done on related issues has been undertaken.

The work plan created by the VGS has been left intentionally broad and leaves room for the individual workgroups to produce a “set of recommendations for standards, regional criteria, enhanced reliability and market interface tools, and methodologies for integrating variable generation in the most cost effective and reliable manner,” according to the work plan itself. The following Figures 5.1 and 5.2 show the issues identified by the VGS as those that need further study by the group and the specific actions they will undertake in tackling those issues.

**Figure 5.1**

Issues Identified by the VGS	
Ensure the VGS is aware of and participates in relevant NERC and NAESB activities	Standardize modeling and planning criteria and methodologies
Identify practices for energy delivery capacity, and generation scheduling of VG resources	Examine the need for a centralized database of VG information
Examine effects of a REC market on VG placements, energy marketing, and system reliability.	Identify performance requirements of VG technologies
Identify ancillary service requirements, and new and/or enhanced delivery mechanisms	Analyze the impact of technology cost changes on resource allocation and transmission planning
Identify and analyze feasibility of new/enhanced tools required by system operators to reliably integrate increasing amounts of VG	Determine the role of complementary technologies in aiding the integration of VG

**Figure 5.2**

<b>Marketing Workgroup</b>
<ul style="list-style-type: none"> <li>• Evaluate NAESB activities as appropriate</li> </ul>
<ul style="list-style-type: none"> <li>• Investigate product codes used in scheduling of variable generation resources and alternative energy scheduling strategies for variable generation resources</li> </ul>
<ul style="list-style-type: none"> <li>• Evaluate the impacts of REC markets</li> </ul>
<ul style="list-style-type: none"> <li>• Investigate new approaches to address how ancillary services will be supplied for variable generation</li> </ul>
<b>Operating Workgroup</b>
<ul style="list-style-type: none"> <li>• Assess methodologies for determining reserve requirements to facilitate reliable integration of variable generation</li> </ul>
<ul style="list-style-type: none"> <li>• Inventory variable generation performance standards and propose modifications where gaps exist</li> </ul>
<ul style="list-style-type: none"> <li>• Investigate mechanisms for better utilizing resource flexibility</li> </ul>
<ul style="list-style-type: none"> <li>• Inventory forecasting practices</li> </ul>
<ul style="list-style-type: none"> <li>• Quantify the benefits of balancing authority consolidation</li> </ul>
<b>Planning Workgroup</b>
<ul style="list-style-type: none"> <li>• Participate in variable generator model validation</li> </ul>
<ul style="list-style-type: none"> <li>• Review the North American Electric Reliability Corporation (NERC) Integrated Variable Generation Task Force report and participate in relevant NERC activities</li> </ul>
<ul style="list-style-type: none"> <li>• Investigate transmission capacity assignment for variable generation resources</li> </ul>
<ul style="list-style-type: none"> <li>• Inventory best practices and provide recommendations to aid in the standardizing and validating of planning criteria and methodologies and interconnection standards</li> </ul>
<ul style="list-style-type: none"> <li>• Provide input to transmission adequacy analyses for accommodating the integration of variable generation</li> </ul>
<ul style="list-style-type: none"> <li>• Create a centralized database for variable generation information</li> </ul>
<ul style="list-style-type: none"> <li>• Develop a variable generation-heavy case for WECC Technical Studies Subcommittee and WECC System Review Work Group to use in analyzing dynamics related issues</li> </ul>
<b>Technology Workgroup</b>
<ul style="list-style-type: none"> <li>• Investigate performance requirements for variable generation technologies</li> </ul>
<ul style="list-style-type: none"> <li>• Evaluate the impact of technology cost changes on resource allocation and transmission planning</li> </ul>
<ul style="list-style-type: none"> <li>• Identify complementary technologies to aid in the integration of variable generation</li> </ul>

Once completed, each of these action items is expected to make integrating variable generation within the Western Interconnect easier and more transparent.

The VGS is not the only forum for discussion related to integration costs in the western US. As states impose RPSs and the demand for renewable generation increases, many utilities and regional groups are releasing studies of their own discussing how the issue of variable integration and the associated costs should be addressed.

One such report is the Northwest Wind Integration Action Plan. The Action Plan was released in 2007 by the Northwest Power and Conservation Council with authors comprised of members from utilities in Montana, Idaho, Oregon and Washington. The Action Plan was undertaken to provide a set of recommendations on issues that need to be addressed and resolved for wind power to achieve its full potential in the Northwest. The Plan offers a list of 16 action items intended to solve the aforementioned issues. The complete list can be found in Appendix 1 of this Report, but in general the goals target the removal of regulatory, transmission and cost barriers that inhibit the development of wind energy.

Another component of the Action Plan is a summary of integration costs gathered from wind integration studies done by Northwest utilities Avista, Idaho Power, Puget Sound Energy, and PacifiCorp. The wind integration costs from that summary are shown below in Table 5.3 with the percentages at the top of the table representing various penetration levels<sup>3</sup>.

**Table 5.3**

Utility	Peak Load (MW)	5%	10%	20%	30%
<b>Avista</b>	2,200	\$2.75	\$6.99	\$6.65	\$8.84
<b>Idaho Power</b>	3,100	Not run	\$9.75	\$11.72	\$16.16
<b>Puget Sound Energy</b>	4,650	\$3.73	\$4.06	Not run	Not run
<b>PacifiCorp</b>	9,400	\$1.86	\$3.19	\$5.94	Not run

Utility	Peak Load (MW)	5%	10%	20%	30%
<b>BPA</b>	9,090	\$1.90	\$2.40	\$3.70	\$4.60

<sup>3</sup> Penetration in this instance is defined as installed wind divided by peak load.

Although the studies the Action Plan used in populating the table above are several years old, the table provides a graphic representation of how varied integration costs can depend on the penetration level and the geographical location of the resources. At a 20% penetration level, integration costs shown above range anywhere from \$3.70 to \$11.72 per MWh. This reflects one of the toughest challenges to renewable developers and utilities wanting to add wind to their renewable portfolio: variable integration charges are a major driver in the utility's bottom line and a cost factor that is so unpredictable it poses significant economic risk.

PacifiCorp has recently updated their wind integration cost estimates since the Northwest Wind Integration Action Plan was released. The results, taken from their 2008 Integrated Resource Plan (IRP), are shown below in Table 5.4. Variable integration cost estimates have increased from \$1.86-\$5.94, to \$9.96 to \$11.85.

**Table 5.4**

CO <sub>2</sub> Cost Scenario	System Balancing Cost (Inter hour)			Intra hour Cost (\$/Expected MWh)	Total (\$/Expected MWh)
	Expected to Day Ahead Cost (\$/Expected MWh)	Day Ahead to Hour Ahead Cost (\$/Expected MWh)	Total Cost (\$/Expected MWh)		
\$8 tax	\$0.28	\$2.17	\$2.45	\$7.51	\$9.96
\$15 tax	\$0.28	\$2.17	\$2.45	\$9.10	\$11.85

On a national level, the U.S. Department of Energy's (DOE) Energy Efficiency & Renewable Energy (EERE) group's annual Wind Technologies Market Report provides a high-level review of the wind industry nationwide. One component of this report is an overview of integration studies done by utilities nationwide. The Report further emphasizes the case for highly fluctuating integration costs dependent on a variety of variables such as geographical location, penetration level, and the average Class of wind resource utilized by the utility. The findings from this portion of the DOE's 2008 report are shown below in Table 5.5.

**Table 5.5**

Date	Study	Wind Capacity Penetration	Integration Cost (\$/MWh)				TOTAL
			Regulation	Load Following	Unit Commit.	Gas Supply	
2003	Xcel-UWIG	3.5%	0	0.41	1.44	na	1.85
2003	We Energies	29%	1.02	0.15	1.75	na	2.92
2004	Xcel-MNDOC	15%	0.23	na	4.37	na	4.60
2005	PacifiCorp-2004	11%	0	1.48	3.16	na	4.64
2006	Calif. (multi-year)*	4%	0.45	trace	trace	na	0.45
2006	Xcel-PSCo	15%	0.20	na	3.32	1.45	4.97
2006	MN-MISO**	31%	na	na	na	na	4.41
2007	Puget Sound Energy	12%	na	na	na	na	6.94
2007	Arizona Pub. Service	15%	0.37	2.65	1.06	na	4.08
2007	Avista Utilities	30%	1.43	4.40	3.00	na	8.84
2007	Idaho Power	20%	na	na	na	na	7.92
2007	PacifiCorp-2007	18%	na	1.10	4.00	na	5.10
2008	Xcel-PSCo***	20%	na	na	na	na	8.56

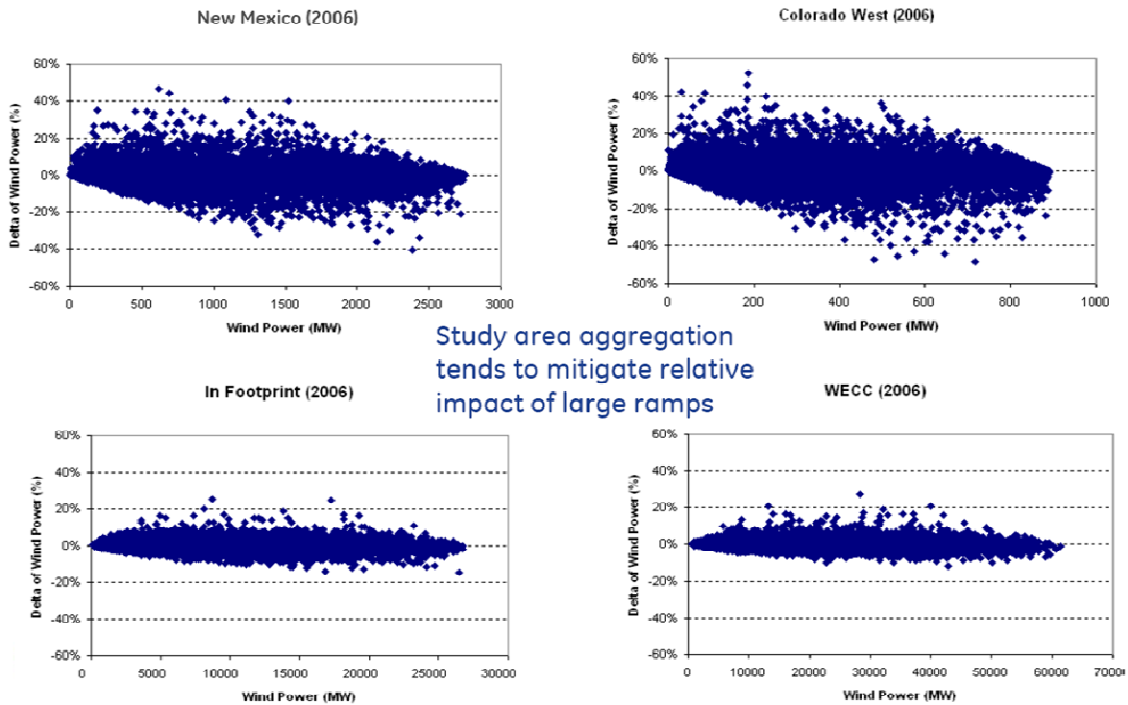
\* Regulation costs represent 3-year average.

\*\* Highest over 3-year evaluation period.

\*\*\* This integration cost reflects a \$10/MMBtu natural gas price scenario. This cost is much higher than the integration cost calculated for Xcel-PSCo in 2006, in large measure due to the higher natural gas price: had the gas price from the 2006 study been used in the 2008 study, the integration cost would drop to \$5.13/MWh.

One proposed solution to mitigating some of these integration costs is increasing the geographic diversity of a utility’s wind profile, or aggregating wind energy from geographically diverse areas. The Western Wind and Solar Integration Study is being done by a collaborative including 3Tier, GE, NREL and utilities such as Arizona Public Service, El Paso Electric, NV Energy, Public Service of New Mexico, Salt River Project, Tri-State G&T, Tucson Electric Power and Xcel Energy. The group’s goal is to “understand the costs and operating impacts due to the variability and uncertainty of wind, PV and concentrating solar power (CSP) on the WestConnect grid” (WestConnect encompasses Nevada, Arizona and portions of Wyoming, Colorado and New Mexico). The report has not yet been released in draft form. However, preliminary results show decreasing variability (and thus decreasing integration charges) when wind is aggregated from a larger and more geographically diverse area. These results are shown graphically in Figure 5.6 below, which compares the wind variability from two individual states, Colorado and New Mexico, with the wind variability from the WestConnect footprint and that of WECC as a whole. The amount of variation is significantly lower for the two regional areas as opposed to the individual states. Given these results, it is reasonable to assume that utilities with a more geographically diverse wind portfolio would see lower wind variability than those with a less diverse wind portfolio.

**Figure 5.6**



Source: Western Wind and Solar Integration Study

## 6 ECONOMIC EVALUATION

Montana has significant amounts of high-density wind compared to other Western states. However, major transmission projects must materialize in order to transport Montana wind to major energy markets in the West. Because of the distance between Montana’s resources and major load centers in the West, it will be especially important for wind project developers to consider which western markets will be the most likely to support Montana generated wind energy.

Exporting Montana’s wind resources to the East is generally not considered practical as electricity demand is insubstantial directly east of Montana and both of Montana’s neighbors to the east, North and South Dakota, have significant, high quality wind resources with which Montana would have to compete. Additionally, the intertie that connects the WECC to the MRO is physically constrained and in order to export energy east, the existing interties would have to be upgraded, or new transmission added, resulting in higher costs for Montana resources. For these reasons, only western energy

markets were considered when comparing the economic viability of Montana wind to that from other states in the West.

In this report, the Western Renewable Energy Zone Generation (WREZ) and Transmission Model was used to compare energy markets in the western US and determine which markets would be the most competitive for Montana wind resources. The WREZ model was developed to simplify a complex highly technical analysis into a spreadsheet analysis that is driven by user assumptions. As a simplified high level screening tool the model reduces planning to a limited set of interactions to estimate the relative economic attractiveness of delivering power from specific renewable energy zones to existing load centers.

## **6.1 WESTERN RENEWABLE ENERGY ZONE INITIATIVE**

The WREZ initiative was developed as a joint initiative between the western Governors Association and the U.S. Department of Energy as a result of a 2006 report from the Western Governors Association entitled “Clean Energy, A Strong Economy and a Healthy Environment.” The report explained the transmission gaps separating large areas of renewable resources in the West and the western United States’ major transmission centers. The report proclaimed, “Lack of cost effective transmission access was, and remains, the greatest impediment to the rapid development of utility-scale, renewable-rich resource areas.”

The WREZ initiative was launched in May of 2008 with four primary goals:

1. Develop a framework for consensus among the states and provinces within the Western Interconnection on how best to develop and deliver energy from renewable resource areas to load centers.
2. Generate reliable information for use by decision makers that supports the cost-effective and environmentally sensitive development of renewable energy in or near certain identified renewable energy zones, as well as the conceptual transmission plans needed to deliver the renewable energy to lead centers.
3. Provide a foundation for interstate collaboration on commercial delivery of renewable energy to meet growing demand throughout the Western Interconnection.

4. Provide the development of cost-effective renewable resources in order to promote the clean and diversified energy goals of the Western governors.

The overarching goal of the WREZ initiative is to define renewable energy zones that are areas comprised of high value, high density renewable resources and then facilitate the development of cost-effective transmission access to these renewable energy zones.

One component of this initiative is the WREZ Generation and Transmission Model (GTM). This model was designed as a preliminary screening tool to allow generators, regulators and developers to quantify and compare the cost of delivering renewable resources to load zones throughout western North America. The model is designed so that users can develop portfolios of resources, deliver the energy to load zones and then evaluate the results. The product of the GTM is cost information for the user-selected resource portfolios at different markets. This result allows a high level economic evaluation between resources from the West delivered to various load centers within the western US. The GMT was used in this report to compare wind resources from states across the West at various major energy markets within WECC and make a determination as to which markets Montana wind resources would be most competitive.

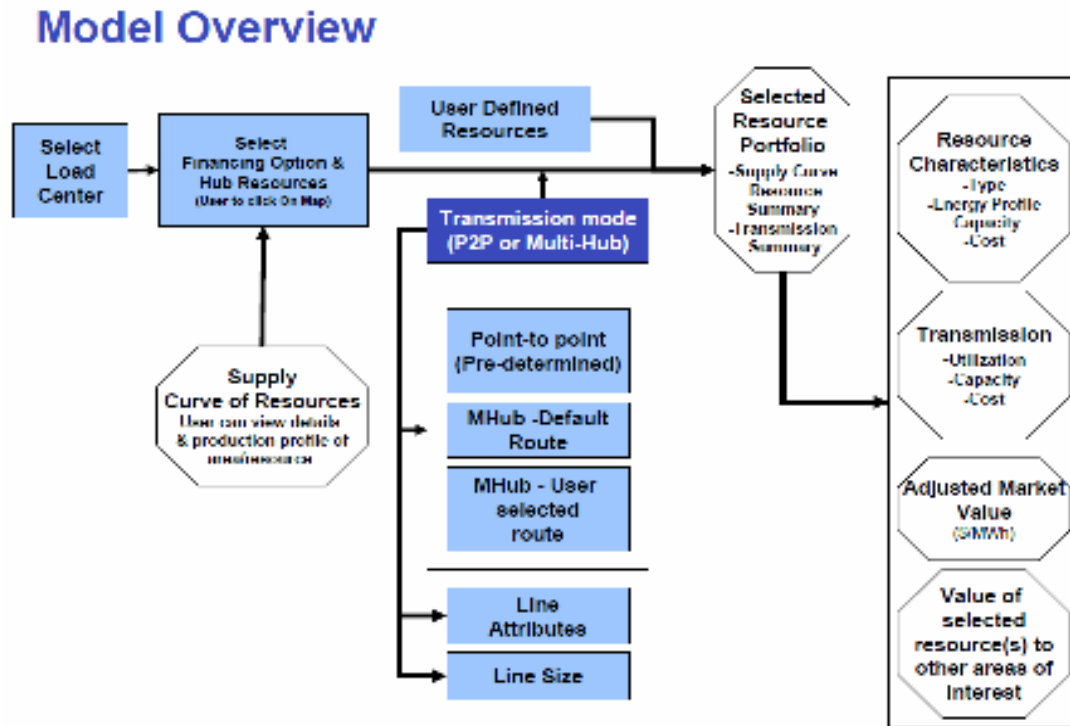
When analyzing output from the WREZ GTM model, it's important to bear in mind that the model was developed as a screening tool for estimating relative economic attractiveness of delivering power from specific renewable energy zones to existing load centers. The model is designed to vary load, generation and transmission assumptions in order to gain insight about delivered costs of renewable energy in different end markets. It does not entail any transmission simulation modeling. Those efforts would only be done by transmission providers/developers once a particular transmission path was selected for detailed study. The model also does not address such items as diversity benefits or transmission upgrades, or special strategies remote states might adopt, such as local firming.

## **6.2 THE WREZ GENERATION AND TRANSMISSION MODEL**

Figure 6.2 below describes the general methodology utilized in the GTM. One of the main components of the WREZ GTM relevant to the evaluation undertaken here is what

wind resources the model uses in comparing various wind energy-related costs. Because wind resources differ so greatly from state to state, the WREZ Phase One Report, as well as the GTM chose to model the best of each resource type on a state-by-state basis. This decision was made because of the assumption that the “best renewable energy resources are most economical to develop and will be developed first, subject to the availability of transmission.” In other words, since Wyoming has such a substantial wind resource, if the minimum threshold for study qualification was determined based on that state, it would essentially eliminate all wind energy from qualifying in states with less substantial wind resources. The GTM uses the same set of NREL wind data that was used in previous sections of this report, then screens out the best available sites initially by eliminating wind sites less than Class 3, as well as each site where the terrain slope was greater than 20%. The GTM then further screened wind sources by determining a best-in Class scenario. In other words, the resource zones were then determined by selecting resource areas with the highest potential to justify regional transmission investment.

**Figure 6.2**



The next part of the model that plays an important role is the load centers utilized. As one of the goals of this report is to determine the markets for which Montana wind is most competitive, the model above was run for all the possible load centers and then the results filtered so that the areas where wind from Montana was the most

competitive were identified. The group of load centers included in the model was based on the major substations in the western US and a list of the hubs and load centers can be seen below in Table 6.2.

**Table 6.2**

## Load Zones

Metro Area	Substation
VANCOUVER	Ingledow
SEATTLE	Monroe
SPOKANE	Bell
PORTLAND	Bethel
SAN FRANCISCO	Vaca-Dixon
SACRAMENTO	Bellota
LOS ANGELES	Serrano
SAN DIEGO	Los Coches
LAS VEGAS	Mead
RENO	Tracy
PHEONIX	Westwing
TUCSON	Tortolita
DENVER	Ault
ALBUQUERQUE	Rio Puerco
SALT LAKE CITY	Terminal
BOISE	Midpoint
BILLINGS	Broadview
CASPER	Casper North
El Paso	Caliente
CALGARY	Janet

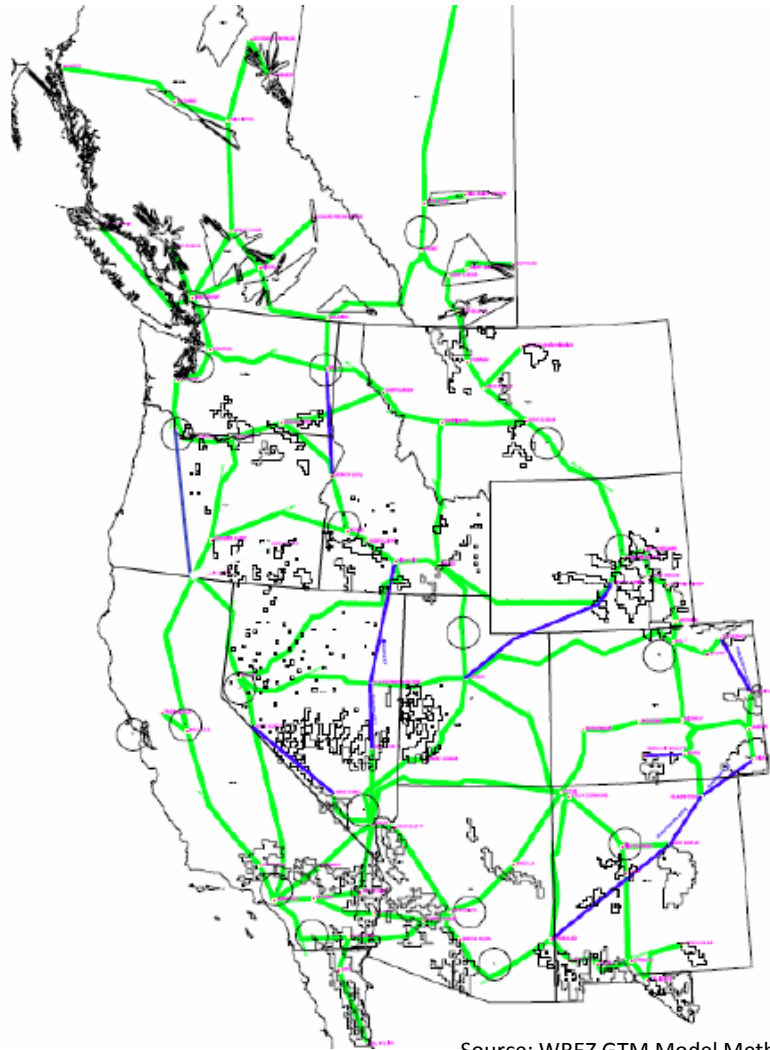
Source: GTMWG Transmission Segments Working Group

Once the resource and the load center have been identified, the model runs the resource through a variety of costs to arrive at the adjusted weighted cost. The primary cost figures utilized in the GTM are the levelized cost of energy (LCOE), sometimes referred to as the busbar cost, and the transmission cost. The LCOE is the cost of the generated energy and takes into account variables such as operation and maintenance, capacity factor and project cost. The LCOE is a total life-cycle cost of generating at a facility divided by the total generation from the facility. It is calculated utilizing a pro forma model and includes all costs incurred transporting the generation to the high-voltage transmission system.

The transmission costs utilized in the GTM are also derived utilizing a pro forma model whose inputs include: capital cost (includes construction, substations & right of way),

transmission line capacity, transmission line utilization factor, and fixed operation and maintenance cost. The WREZ modeled transmission system is shown below in Figure 6.3. The GTM utilizes a representation of the major transmission paths in WECC with several segment additions that are not based on specific proposed projects.

**Figure 6.3**



Source: WREZ GTM Model Methodology & Assumptions

The model then combines the LCOE and the transmission costs to arrive at a Delivered Cost. While this delivered cost represents the potential cost of a resource at the load center, the GTM presents the ultimate results of the modeling in terms of an adjusted delivered cost, or what the value of a resource is to a load zone. This adjusted delivered cost takes “the energy and capacity benefit delivered by the resource” into consideration according to the WREZ GTM Model Methodology and Assumptions.

The adjusted delivered cost is comprised of the LCOE plus the transmission cost and integration costs, minus the energy value and the capacity value. As described above in Section 5, the integration cost of a generation project is the indirect operation cost to the transmission grid to accommodate the generation from the project into the grid. It is considerably higher for renewable resources such as solar and wind because of their intermittent nature. In the GTM, a wind integration cost of \$5/MWh was assigned to wind generation.

The energy value used in the GTM is the value of the resource's output at the specific load zone, or in other words, the load zone's marginal cost. Energy values utilized in this section are based on 2015 market forecast in 2009 dollars using the ProMod production cost model.

The last component of the adjusted delivered cost is the capacity value. The capacity value is the avoided expense of using an alternative source of capacity, such as a gas turbine generator.

The adjusted delivered cost then represents the value of each evaluated resource to the specific load zone, after accounting for the energy and capacity benefit derived from the resource. When viewing the modeling results, it is important to differentiate this adjusted delivered cost from the delivered cost. The adjusted delivered cost is not a prediction of what wind resources will actually cost at various market hubs, but merely a metric utilized in the GTM and here to compare what resources will be the most valuable at market hubs compared to resources from other areas.

Energy Strategies selected the areas identified by the WREZ initiative as the best wind resources in Montana and then had the GTM deliver the resource to markets in the western US. Shown below in Table 6.3 are the results of the model which reflect the markets that are the most economically compatible to Montana wind resources, and how Montana wind would compare to other resources at that specific Market hub. The top seven most competitive results are shown below, and the results in their entirety can be seen in Appendix 2. Furthermore, the results shown in Appendix 2 show where Montana wind resources ranked in the markets for which the resource was not listed in the top 5.

Montana hubs such as Billings were excluded from the results as there is not expected to be a significant market for Montana wind energy within the state, nor is that the focus of this report. Also excluded were Wyoming resources, as there is not expected to be a major market for Montana wind resources within that state given Wyoming's own

major wind resources. The GTM determined the most competitive markets for Montana wind resources in 2015 will be Calgary, Spokane, Portland, Seattle and Boise.

**Table 6.3**

<b>Market: Calgary</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	AB	-\$6.43	13,579	13,579
2	MT	\$6.21	32,555	46,134
3	WY	\$52.49	48,918	95,052
4	OR	\$65.18	7,479	102,531
5	WA	\$67.03	8,230	110,761
<b>Market: Spokane</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$30.14	8,230	8,230
2	MT	\$31.05	32,555	40,785
3	OR	\$31.63	7,479	48,264
4	AB	\$33.65	13,579	61,844
5	WY	\$56.50	48,918	110,761
<b>Market: Portland</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$15.36	8,230	8,230
2	OR	\$24.67	7,479	15,709
3	MT	\$63.52	32,555	48,264
4	ID	\$70.02	4,080	52,344
5	AB	\$71.45	13,579	65,923
<b>Market: Seattle</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$40.68	8,230	8,230
2	OR	\$47.61	7,479	15,709
3	MT	\$53.16	32,555	48,264
4	AB	\$56.56	13,579	61,844
5	BC	\$70.90	34,104	95,947

**Figure 6.3 Continued**

<b>Market: Boise</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$29.00	48,918	48,918
2	ID	\$43.31	4,080	52,997
3	MT	\$53.98	32,555	85,552
4	OR	\$79.87	7,479	93,031
5	AB	\$83.60	13,579	106,611
<b>Market: Denver</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$36.18	48,918	48,918
2	NM	\$74.31	36,581	85,499
3	MT	\$87.37	32,555	118,054
4	UT	\$109.91	4,176	122,230
5	AB	\$117.84	13,579	135,809
<b>Market: Salt Lake City</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$54.01	48,918	48,918
2	ID	\$55.50	4,080	52,997
3	UT	\$57.98	4,176	57,173
4	MT	\$66.81	32,555	89,728
5	NM	\$87.40	36,581	126,310

## 7 CONCLUSIONS

There is projected to be a significant increase in electricity demand in the Western US over the next twenty years. As a result of renewable portfolio standards, a portion of this demand will need to be met with renewable resources. It is estimated that the West will need an additional 108,000 GWh of renewable energy by 2020 to meet current RPS standards.

Montana has considerable wind resources that could help meet that need. The analysis undertaken indicates that Montana's wind resources are the greatest in the West in terms of total generation potential, and second in the western half of the country in terms of high-class wind resource potential. The Montana wind resources are also shown to have a wind profile (both seasonal and time of day) that enhances its economic attractiveness. Given its inherent strong profile, a key to market success remains the ability to transport Montana wind to out-of-state markets. Several proposed transmission lines are expected to facilitate significant wind energy development and will help move Montana's wind power to load centers. With the addition of these lines, Montana's wind resources will likely play a major role in helping the region meet its RPS and GHG reduction goals. As shown above in Figure 6.3, Montana wind resources are the most competitive in regions that have a close proximity to the state itself. Montana wind will clearly have an economic advantage in markets in the Pacific Northwest and Calgary. However, Montana wind's competitive position within other regional markets, including those located in the Desert Southwest and California, should also be considered potentially strong. The future development of key transmission lines to these sub-markets should improve the Montana resources economic competitiveness in what will be highly contested markets. The degree of competitiveness will ultimately depend on a multitude of factors, such as local firming/valuation of diversity benefits and or state programs aimed at enhancing a particular area's resource attractiveness.

As mentioned above, successful completion of new transmission lines will be critical to reach markets that demand wind energy. The Montana Alberta Tie Line and the Colstrip Upgrade will aide in exporting increasing amounts of Montana wind to the markets identified by the WREZ model in the Pacific Northwest and Alberta. Similarly, successful completion of the Chinook, Mountain States Intertie, and Grasslands Renewable Energy lines will open opportunities for Montana wind to compete with other renewable resources in the growing markets in the Desert Southwest and California.

While the large scale development of Montana resources faces challenges, it is an abundant and high quality resource that there is growing demand for regionally.

Montana wind resources are expected to play a large role in helping the West meet a growing demand for renewable energy in the future.

## Appendix 1

### Summary of Action Plan Items

- 1) The Northwest Resource Adequacy Forum should reassess its 15 percent pilot sustained wind capacity value.
- 2) Northwest utilities should continue to refine their estimates of wind integration costs using a robust stakeholder process and develop estimates of potential cost reductions from control area cooperation, more active markets for control area services and other strategies.
- 3) The Northwest Wind Integration Forum should contract for the development of a high resolution wind resource data set for the Pacific Northwest.
- 4) The Northwest Transmission Assessment Committee (NTAC) should propose a formal technical transmission planning methodology that seeks a balance between the cost of transmission capacity and the value of delivered wind energy.
- 5) Columbia Grid and the Northern Tier Transmission Group, together with NTAC, should begin applying the NTAC transmission planning methodology to regional transmission planning.
- 6) The four state regulatory commissions should review and amend as necessary regulatory policies to remove barriers to more efficient use of transmission for wind and other renewable resources.
- 7) BPA and other Northwest parties should explore ways to make more efficient use of existing transmission infrastructure, such as conditional firm transmission service and redispatch.
- 8) BPA should complete plans of service and review the business cases for the proposed West of McNary, I-5 Corridor and Cross-Cascades transmission reinforcements.
- 9) BPA should develop a general model for financing market-driven transmission improvements, using the proposed West of McNary project as a prototype.
- 10) NTAC, building on the results of the Rocky Mountain Area Transmission Study (RMATS), should evaluate approaches to delivering wind energy from Montana such as an upgrade of the 500kV system in Montana, and evaluate opportunities to deliver wind energy from other isolated wind resource areas.
- 11) The Northwest Wind Integration Forum should evaluate the costs and benefits of a regional wind forecasting network and, if positive, develop an implementation plan.
- 12) The participants in the ACE Diversity Interchange pilot should provide a progress report to the Steering Committee of the Northwest Wind Integration Forum.
- 13) The Northwest Wind Integration Forum should address barriers to expanding the market for control area services and wind integration products.
- 14) The Northwest Wind Integration Forum should characterize options for augmenting system flexibility. The Northwest Power and Conservation Council (Council) should complete Action GEN-9 of its Fifth Power Plan to improve understanding of the tradeoffs between competing uses of system flexibility in an increasingly carbon constrained environment.

- 15) The Council, in future power plans, should incorporate a planning framework to maximize the economic and environmental value of wind energy.
- 16) The Council, working with BPA and other interested organizations, should establish a Northwest Wind Integration Forum to facilitate implementation of the actions called for in this Action Plan.

## Appendix 2

Market: Calgary				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	AB	-\$6.43	13,579	13,579
2	MT	\$6.21	32,555	46,134
3	WY	\$52.49	48,918	95,052
4	OR	\$65.18	7,479	102,531
5	WA	\$67.03	8,230	110,761
Market: Spokane				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$30.14	8,230	8,230
2	MT	\$31.05	32,555	40,785
3	OR	\$31.63	7,479	48,264
4	AB	\$33.65	13,579	61,844
5	WY	\$56.50	48,918	110,761
Market: Portland				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$15.36	8,230	8,230
2	OR	\$24.67	7,479	15,709
3	MT	\$63.52	32,555	48,264
4	ID	\$70.02	4,080	52,344
5	AB	\$71.45	13,579	65,923
Market: Seattle				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$40.68	8,230	8,230
2	OR	\$47.61	7,479	15,709
3	MT	\$53.16	32,555	48,264
4	AB	\$56.56	13,579	61,844
5	BC	\$70.90	34,104	95,947
Market: Boise				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$29.00	48,918	48,918
2	ID	\$43.31	4,080	52,997
3	MT	\$53.98	32,555	85,552
4	OR	\$79.87	7,479	93,031
5	AB	\$83.60	13,579	106,611
Market: Denver				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$36.18	48,918	48,918
2	NM	\$74.31	36,581	85,499
3	MT	\$87.37	32,555	118,054
4	UT	\$109.91	4,176	122,230
5	AB	\$117.84	13,579	135,809

<b>Market: Salt Lake City</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$54.01	48,918	48,918
2	ID	\$55.50	4,080	52,997
3	UT	\$57.98	4,176	57,173
4	MT	\$66.81	32,555	89,728
5	NM	\$87.40	36,581	126,310
<b>Market: Reno</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	NV	\$50.54	1,085	1,085
2	OR	\$70.93	7,479	8,564
3	ID	\$73.59	4,080	12,644
4	CA	\$74.79	16,122	28,766
5	WY	\$78.80	48,918	77,683
8	MT	\$90.82	32,555	122,645
<b>Market: Las Vegas</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	UT	\$44.23	4,176	4,176
2	NV	\$44.33	1,085	5,261
3	CA	\$46.50	16,122	21,383
4	WY	\$71.17	48,918	70,301
5	NM	\$82.13	36,581	106,882
7	MT	\$98.51	32,555	143,517
<b>Market: Sacramento</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	CA	\$55.50	16,122	16,122
2	OR	\$74.70	7,479	23,601
3	WA	\$91.75	8,230	31,831
4	ID	\$99.02	4,080	35,911
5	NV	\$99.16	1,085	36,996
7	MT	\$114.37	32,555	73,727
<b>Market: San Francisco</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	CA	\$63.81	16,122	16,122
2	OR	\$83.08	7,479	23,601
3	WA	\$100.40	8,230	31,831
4	NV	\$107.86	1,085	32,917
5	ID	\$107.92	4,080	36,996
7	MT	\$121.37	32,555	73,727

<b>Market: Los_Angeles</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	CA	\$24.98	16,122	16,122
2	NV	\$66.34	1,085	17,207
3	UT	\$66.53	4,176	21,383
4	WY	\$86.55	48,918	70,301
5	NM	\$103.49	36,581	106,882
8	MT	\$117.65	32,555	150,996
<b>Market: San_Diego</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	CA	\$37.04	16,122	16,122
2	NV	\$80.28	1,085	17,207
3	UT	\$80.58	4,176	21,383
4	WY	\$103.76	48,918	70,301
5	NM	\$103.82	36,581	106,882
8	MT	\$131.36	32,555	150,996
<b>Market: Billings</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	MT	\$27.47	32,555	32,555
2	WY	\$44.00	48,918	81,473
3	AB	\$53.10	13,579	95,052
4	ID	\$97.20	4,080	99,132
5	OR	\$104.45	7,479	106,611
<b>Market: Casper</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WY	\$29.89	48,918	48,918
2	MT	\$57.66	32,555	81,473
3	AB	\$85.74	13,579	95,052
4	ID	\$97.15	4,080	99,132
5	UT	\$105.89	4,176	103,307
<b>Market: Vancouver</b>				
Rank Based on Lowest Price	State	Adj. Weighted Price \$/MWh	Generation (GWh)	Cumulative Generation (GWh)
1	WA	\$47.15	8,230	8,230
2	AB	\$47.99	13,579	21,810
3	BC	\$51.33	34,104	55,913
4	MT	\$51.77	32,555	88,468
5	OR	\$53.42	7,479	95,947