BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of the Application of PacifiCorp for Approval of Power Purchase Agreement Between PacifiCorp and Spanish Fork Wind Park 2, LLC	)	Docket No. 06-035
In the Matter of the Petition of Wasatch Wind, LLC for Approval of a Contract for the Sale of Capacity and Energy from Their Proposed QF Facilities	)	Docket No. 06-035

TESTIMONY OF MARK G. ADAMS

January 31, 2007

Q. Please state your name, business address and position with PacifiCorp dba Rocky Mountain Power.

A. My name is Mark G. Adams. My business address is 1407 W. North Temple Street, Suite 270, Salt Lake City, Utah 84116. I am the Manager of Area Planning for Rocky Mountain Power, and my department is responsible for developing all conceptual planning improvements to the transmission and substation system for Rocky Mountain Power.

QUALIFICATIONS

Q. Please briefly describe your education and business experience.

A. I have a B.S. in Electrical Engineering from the University of Utah. I have been employed with Rocky Mountain Power and its predecessor companies for about thirty years doing different kinds of electrical system planning in the distribution, transmission and area planning groups. During the last twenty years I was responsible for doing transmission system planning in various areas through Utah, Wyoming, Idaho, Montana, Washington and Oregon. I currently manage all area planning work within the Rocky Mountain Power service territory. My group is responsible for evaluating the capacities and capabilities of the PacifiCorp electrical system.

TESTIMONY

Q. What is the purpose of your testimony?

A. I will be responding to the direct testimony of Mr. Rich Collins and Mr. Michael Unger. In particular, I will be addressing technical and engineering related issues as they pertain to the methodology proposed by Mr. Collins.

Q. Please describe any power flow studies you performed in conjunction with the docket.

A. In the direct testimony of Mr. Collins on page 4 line 14, he stated "this makes the calculation conceptually difficult. Even when a method is chosen, the modeling and data requirements make the process very time consuming and expensive". In spite of this, Mr. Collins did ask Rocky Mountain Power to perform multiple studies, even though Mr. Collins could easily have contracted with a third party or performed the studies himself. Rocky Mountain Power was not planning on performing any studies since it did not believe the studies were necessary to calculate line losses according to the methodology recommended by witness Paul Clements in his direct testimony in this case. However, in the spirit of cooperation, Rocky Mountain Power did perform a study which provided a preliminary look at the proxy wind project and the Spanish Fork Wind Park 2 project in preparation for a technical conference in August 2006. The study assumed heavy and light 2006 loading levels using a heavily modified WECC power flow base case and studied the effect of each project being out of service and in-service. At the technical conference, the company shared the results of the study to all members of the conference. The study results indicated two significant conclusions: 1) the losses in both projects were very small and

approached the accuracy of the model, and 2) the Spanish Fork Wind Park project avoided fewer losses than the proxy project.

Q. In your previous response, you mention a "WECC power flow base case." Can you provide a summary of what this is and how it is used?

A. WECC is an acronym for Western Electricity Coordinating Council. It is a part of the North American Electric Reliability Corporation. WECC's mission of maintaining a reliable electric power system in the Western Interconnection and assuring open and nondiscriminatory transmission access among members is accomplished through thousands of hours of labor contributed by WECC's 159 members. The work of the membership is supported by a staff of 24. One of the members is PacifiCorp. One of WECC's tasks is to prepare computer models of the Western electrical grid from data supplied by the 159 members. This data is then provided to all of the members for use in various analyses. The "WECC power flow base case" I mentioned in the previous question is the starting data set for the power flow analysis performed by the company.

Q. **Did you modify the WECC power flow base case? If so, why?**

A. Yes, I did modify the base case. The WECC base cases will primarily only model the high voltage transmission system (generally greater than 230 kV but sometimes including 138 kV), as well as the large system generators for all companies in the western United States. Since both the proxy facility and the Spanish Fork Wind Park 2 facility are or will be connected to the sub-

transmission system, the WECC base cases do not have enough detail to accurately track line and system losses caused by these small wind projects. Rocky Mountain Power does model the sub-transmission facilities (between 12.5 kV and 161 kV) to more accurately gather the loss effects, and therefore modifies the WECC base case model to include the impedance those thousands of miles of lower voltage lines and transformers would add to the system.

Q. **Did Mr. Unger modify the WECC base case model for his studies?**

A. No. Based on the responses to PacifiCorp's data requests received on January 26, 2007, Mr. Unger did not modify the WECC base case.

Q. Can Mr. Unger get accurate data results without modifying the WECC base case for his studies?

A. No. With no sub-transmission representation in the base cases, more than half of all of the system and line losses in the case would be ignored. The purpose of the model is to calculate losses from the source to the distribution loads. If the distribution loads were not included in the model it would be impossible to calculate those losses.

Q. Do you have comments on the first line loss methodology Mr. Collins described on page 6 line 4 of his direct testimony?

A. Yes, I have several comments. First, the method Mr. Collins used can get quite complex. More importantly, Mr. Collins made some incorrect assumptions that

skewed his results. For example, on page 6 line 3, he states that Spanish Fork Wind Park 2 is only 4.5 miles from the Mapleton load. While he is correct in regards to distance, the Mapleton load is never large enough to absorb all of the Spanish Fork Wind Park 2 generation. PacifiCorp's response to Wasatch Wind data request 1.13 states that during peak periods, the Mapleton load is only 10.1 MVA. The Spanish Fork Wind Park 2 nameplate capacity is 18.9 MW. In order to complete Mr. Collins' analysis, his calculations should have also assumed that the either the Orem city load served by the Hale substation, the Santaquin city load served by the 138 kV Summit Creek substation, or the Goshen (Utah) load would also be needed to absorb the wind park generation. Hale is located about 17 miles from Spanish fork or about 19 miles from the Spanish Fork Wind Park 2 project. Goshen is located about 19 miles from the project and Summit Creek is located about 25 line miles from Spanish Fork. Furthermore, during light loading levels it may require all three locations to absorb the full generation from the project. In his calculation for the proxy facility, Mr. Collins made a significant error when he included the 14 mile Wolverine Creek – Goshen 161 kV line in his calculations. Since this line is customer-owned and on the customer side of the primary metering point, any losses incurred across this line would be absorbed by the project owner, not PacifiCorp, and should not be included in the loss calculations. In addition, Mr. Collins also failed to include the presence of the Goshen (Idaho) distribution peak load of 20 MVA that is located right at the Goshen bus (see Wasatch Wind data request 1.10) in his calculations. Had Mr. Collins performed his analysis with this correct information I have outlined

above, the results would have shown the proxy project output has zero miles to travel to be absorbed while the Spanish Fork Wind Park 2 project output must travel 15 to 20 miles to be absorbed.

Q. Is there a better line loss methodology that could be used?

A. Yes. As Mr. Clements stated on Page 6 line 100 of his direct testimony, there is a fairly simple methodology that can be used. This methodology traces the impedance path from the generator interconnection source back to a major transmission source. In the case of the proxy generator, the interconnection point and the transmission source point are both at the Goshen substation, so there is no line distance to calculate losses. In the Case of Spanish Fork Wind Park, the line distance between the inter-connection point and the transmission source point is about 2.2 miles. This method is discussed formally in Mr. Clements' testimony on pages 6-7.

Q. Do you have comments on the line loss methodology Dr. Abdulle described on page 4 line 1 of his direct testimony?

A. Dr. Abdulle included in his calculations the effect of having to absorb the entire 64.5 MW proxy wind project in his calculations. If we were to consider the proxy plant to be the same size as the Spanish Fork Wind Park 2 project, as Mr. Collins did in his direct testimony page 9 line 17, Dr Abdulle's calculations would need to be revised to 0 miles / MW for the proxy project, since there is 20 MVA of distribution load in the Goshen substation. In the case of doing the calculations for the Spanish Fork Wind Park 2 project, he assumed the distance correctly from

Spanish Fork to Santaquin. However, Santaquin is now a 46 kV switching station, which no longer has a transformer to serve distribution loads. The Santaquin load is served by the 138 kV substation at Summit Creek, as I mentioned above. Dr Abdulle's revised calculations for the Spanish Fork Wind Park 2 would be 15.55 miles / MW. I would also submit that during light loading conditions, the average line distance required to absorb the Spanish Fork Wind Park 2 generation is closer to an average of 17-20 line miles plus a 46-138 kV transformation impedance for Hale and a 46-138 kV transformation impedance in the case of Summit Creek (Santaquin). While not entirely consistent with PacifiCorp's proposed methodology described in Mr. Clements' direct testimony, Dr. Abdulle's methodology supports PacifiCorp's recommendation that no adjustment be made to the Spanish Fork Wind Park 2 pricing to account for avoided line losses.

Q. On page 9 line 16 Mr. Collins states "this crude method does not measure where the power actually flows or the impacts on the system as a whole and therefore is not recommended for use." What is your opinion?

A. Mr. Collins is absolutely correct that this method is crude and does not measure where the power actually flows. Unfortunately, there is no cost effective or sufficiently accurate method available to meter actual line losses or to project what line losses will be over the 20 year term of the contract. The available methodologies must resort to theoretical calculations or computer models with complex assumptions to reach any conclusions. Since the goal is to predict the

future line losses over the life of a project, it is impossible to arrive at an answer with scientific confidence. We have already discussed two theoretical calculation methodologies, one by Mr. Clements and one by Dr. Abdulle, and mentioned a more complex computer model algorithm that in each case have concluded that the Spanish Fork Wind Park 2 project would avoid fewer line losses than the proxy project.

Q. Mr. Collins discussed the relative merits of using power flow models to calculate line losses for the life of a project in his direct testimony on pages 10-13 starting in line 1. What is your opinion?

A. Mr. Collins is correct when he said on page 7 line 12 "Unfortunately, the models will not give us an unequivocal answer to the issue of line losses. There are a number of issues that must be resolved". Dr Abdulle is also correct when he said on page 2 line 11, "Line loss is a physical reality whenever electric energy flows in a conductor". So line losses are a continuous phenomena. Power flow studies are used to calculate electrical system conditions (including losses) for an instant in time, based largely on the assumptions made by the user. The studies will calculate voltage drops, current flows and interpolate system losses. In the case of using power flow studies to predict line losses for the life of a project, it would take an infinite series of studies in an attempt to calculate line losses during the project's life. Also, it would require significant assumptions regarding load growth, resource additions, and system upgrades over the term of the QF contract – in this case 20 years. Gathering the exact system loads and generation

requirements and then modeling them in a large series of power flow cases has been done to track real time situations (such as the East coast blackout of a couple of years ago.) However, the use of power flow studies to determine avoided line losses for QFs is expensive and time consuming. To try to predict the future would introduce a great number of uncertainties to the equation and will introduce errors. For example, inaccuracies will occur as you calculate the system load and generation levels (by substation) as they cycle through seconds, minutes, hours, days and years of the future life of a project, especially as we try to predict the various wind generation outputs for these projects. In addition, other variables such as area load growth, economic dispatch, equipment failures, other new facilities, maintenance etc., will affect the power flow study results if incorrect.

Q On page 8 line 18, Mr. Collins describes some of the mechanics that were used to produce the loss studies. Can you comment on the methodology?

A Mr. Collins indicated that "we decided to back down 19 MWs of power produced at Wolverine and inject it into the Spanish Fork substation. We then compared these line losses with the base case." Running the studies with this method introduces a couple of questions. There is no indication that off system devices were "frozen" to eliminate the possibility of other devices introducing additional system losses or reduction of system losses to the system. These devices could be capacitor switching, phase shift transformers changing states, transformer taps changing, or other events. Any of these devices will change voltage states and current flows and modify system losses. The key point is these studies should not

be trying to capture all system losses in the western United States, as we are only trying to capture those losses or reduction of losses (identified by that snapshot in time) that PacifiCorp would incur as a result of the two generation projects. We have already discussed the fact that the customer owned 14 mile Wolverine Creek – Goshen 161 kV line will incorrectly introduce additional losses to the power flow case as performed by Mr. Collins. Since those losses will not be incurred by PacifiCorp, they would need to be discounted from the results. Again there is no indication that these loss reductions were made by Mr. Collins. Next, Mr. Collins indicated that he did his loss comparison work by backing down Wolverine Creek's last 19 MW and adding 19 MW to Spanish Fork Wind Park 2. To get an equivalent comparison should dictate comparing the first 19 MW at the proxy site with 19 MW at the Wind Park site. Even so, this type of analysis or study would do no more than determine if the Idaho transmission ***system*** would have more or less loss capability than the Utah transmission ***system***. It does not measure what line loss increases or line loss reductions PacifiCorp would have to absorb for each project. To measure what line loss increases or line loss reductions PacifiCorp would have to absorb, you would have to assume one project is on and adjust other discretionary generation units, then compare that result with the other project. As would be expected, there are limitations to this methodology as well. A power flow program designates that one of the system generating units be set as the swing machine to track loads for convenience, but in real life, the company adjusts generation output by economics. So, knowing with a certainty which generator would be offset by either project would be impossible to do on a

forward looking basis. The answer might indeed change over the course of a day depending on economic or system conditions. Again, this shows the limitations of using power flow studies to calculate line losses over the life of a project.

Q Mr. Collins introduced power purchases and sales transactions in his testimony on page 9 line 9, as another way to analyze the effects of the wind projects to gather line losses, with generation dropped at COB, Mid Columbia and Four Corners, rather than dropping PacifiCorp generation. Please comment.

A. I have difficulty understanding the advantage of picking arbitrary locations like COB (a location near the California-Oregon Border), Mid-Columbia (a location in central Washington) and Four Corners (a location near the corner of Utah, Arizona, New Mexico and Colorado) to attempt to do loss calculations using power flow studies. These are locations used to make power sales between various western electric utilities, but for the most part they are not generation sites. Mr. Unger in his direct testimony Exhibit 2.1 indicated that he studied generators at Rocky Reach (Washington), Shasta (California), and Cholla (Arizona.) Obviously expanding the model did require further assumptions to be made. Unfortunately, those assumptions have not been outlined. Reviewing his study results, I note that with eleven cases run using various WECC models, total system losses ranged from 3700 MW to 5551 MW. In all cases except one, where the study claimed 25% loss savings, the loss change was less than 1 MW, or from .02 -.03% of the total – a level that may be towards the accuracy of the model

itself. Of the total, four cases showed the losses increased as a result of Spanish Fork Wind Park 2 and six cases showed the losses decreased. In more then half of the cases, the loss change was a few hundred kilowatts, which I believe might be outside the accuracy of the model, especially because they are spread through out the Western United States. Again, I must stress that the model results were not adjusted to account for the fact that PacifiCorp does not incur losses over the project-owned 14 mile line from the proxy project to the Goshen substation delivery point.

Q. Are power flow studies the preferred method to calculate line losses?

A. No, I would agree with Mr. Collins assessment of the limitations of power flow studies when he said on page 7 line 14, "To definitely measure line losses, one would have to run the model for every hour in every year that the resource would be operating. In this case it would be every hour for twenty years. In addition, one would want to run different load scenarios to capture the range of possible future events. Plus, the results are only valid if the assumptions of the base case prove true in reality. Unfortunately, every run is expensive, thus a definitive conclusion may cost more than the value of the avoided line losses." I would submit that the method that would get the best results for effort produced would be the "transmission source" method discussed briefly by me on page 5 line 81 and by Mr. Clements in his testimony beginning on Page 6 line 100.

Q. Does this conclude your testimony?

A. Yes.