Before the Minnesota Public Utilities Commission

State of Minnesota

In the Matter of the Application of Minnesota Power
For Authority to Increase Rates for Electric Utility
Service in Minnesota

Docket No. E015/GR-08-415

Exhibit _____

SALES FORECASTING

Rebuttal Testimony

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I. INTRODUCTION

Q. Please state your name, title, and business address.

A. My name is Robert J. Camfield. I serve in the capacity of Vice President for Christensen Associates Energy Consulting LLC, a wholly owned subsidiary of Laurits R. Christensen Associates, Inc. My business address is 4610 University Avenue, Madison, Wisconsin, 53705.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of Minnesota Power, which has engaged Christensen Associates Energy Consulting to review its forecast methods and process.

Q. What is the scope of your rebuttal testimony?

A. I describe Minnesota Power's approach to load and energy forecasting, as detailed in the Company's Annual Electric Utility Forecast Report, otherwise referred to as the Advance Forecast Report ("AFR"). I present the results of my review of the Company's forecast approach, which is benchmarked with respect to methods generally utilized by electricity service providers. In particular, my review focuses on the underlying reasons for the Company's monthly forecast for budget ("MFB") and for the calibration of the monthly forecast to the Company's AFR.

My rebuttal testimony also addresses key issues raised in the direct testimony of Office of Energy Security ("OES") witness Adam Heinen. Specifically, I respond to Mr. Heinen's criticism that the Company's forecast methods contain statistical bias, which he claims systematically result in understated test year sales levels that cannot be used to determine retail electricity rates in the immediate docket before the Minnesota Public Utilities Commission ("Commission"). Finally, my testimony addresses the viability and usefulness of the alternative forecasting approach and sales levels proposed by Mr. Heinen for setting retail electric rates.

Q. What qualifies you to present testimony on the topics that you identify above?

A. The scope of my professional work includes capital valuation, electricity demand and load forecasting, cost assessment, regulatory economics and governance, and wholesale contracts and negotiation. I have developed load forecasts, and I have served on load forecast review committees, expert panels, and regional forecast groups. I have reviewed load and energy forecast processes and techniques of electric utilities and advised utilities on forecast methods. I have conducted several regional economic studies focused on the impacts of construction projects and electricity prices.

My clients include electric utilities, cooperatives, consumer advocacy groups, regulatory agencies, municipalities, industrial customers of electric utilities, law firms, investment banking firms, electric industry associations, transmission companies, generation companies, RTOs, distribution companies, and industry research groups. I have testified and made appearances on behalf of clients in evidentiary proceedings and other formal regulatory settings on a range of topics including corporate performance, cost of capital and rate of return, cost escalation, power supply contracts, load and energy forecasting, cost benchmarking, transmission congestion, marginal costs and cost allocation, tariff design and utility rate phase-in plans, cost benchmarking, and generation supply plans.

My previous assignments include the assessment of demand-side strategies and the management of electric and gas rate cases, contract terms for renewable resources, power supply solicitations, and electricity market restructuring in Central Europe. I have initiated or been involved in several innovations including two-part tariffs for transmission services, web-based self-designing retail electric products, marginal cost-based cost allocation methods, and the development of principles for efficient pricing of distribution services. I have served as a member of the economics committee of the National Association of Regulatory Utility Commissioners and on an advisory panel for EPRI. I have published reports, chapters in technical books, and articles in noted journals such as *The Electricity Journal*, *IEEE Transactions on Power Systems*, and the *Council on Large Electric Systems*. Currently, I serve as Program Director of the Edison Electric Institute's

Market Design and Transmission Pricing School. I have held the position of chief economist for a regulatory agency, and system economist for a large, integrated electric service provider. I hold a masters degree in economics from Western Michigan University, and I am a graduate of Interlochen Arts Academy.

II. SUMMARY OF TESTIMONY

Q. Please summarize the conclusions of your rebuttal testimony and recommendations?

A. I highlight four major findings from my review of Minnesota Power's load and energy forecast process and results below.

1. Minnesota Power's Forecasting Methods Are Consistent with Industry Practices and Are Applied With an Appropriate Level of Articulation and Detail.

   The load forecasting approach employed by Minnesota Power is well within the realm of methods utilized by the electricity industry currently. The Company's sales forecast provides a firm basis for the Commission's determination of the Company's general rates. Specific strengths of the Company's forecast process are identified below.

   a) Minnesota Power applies statistical tools tailored specifically to electricity forecasting.

   b) The statistical analysis (econometric models) and data inputs for the various customer groups/classes are specified and developed with the necessary attention to detail. Where appropriate, the Company recognizes the impact of weather on sales.

   c) Forecast drivers (exogenous input factors) utilized by the Company are developed from a consensus view of the outlook for the macro U.S. economy by economic forecast services. Forecast drivers are then utilized in simulations specific to the Minnesota counties represented within the Company's service territory.

d) Minnesota Power's forecast process utilizes information and data specific to the individual large industrial customers that it serves. These data are gathered through the Company's close dialogue with its industrial customers, and are utilized systematically within (general equilibrium) model simulations to determine the primary and second-order effects of expected industrial expansion. Similarly, the Company's forecasters subtract out, also through simulation, the effects of previous plant expansion from the historical data series in order to avoid double counting.

e) The Company's forecast process utilizes a secondary monthly forecast process to obtain a more articulate representation of the monthly distribution of projections of annual sales, as determined within the AFR process.

2. Minnesota Power's Estimates of Billing Determinants Capture the Expected Value of Sales for the Test Period and Are Accurate.

The Company's projections of load and energy over the near term, including the test period, are representative and accurate. The Company commits the necessary level of resources to assist large power customers, and to understand their large power customers' business contexts at an individual customer level. This feature of the Company's overall approach, referred to as direct contact, enables the Company to realize high levels of forecast accuracy. The direct contact basis for the near term sales projection is particularly important in view of the exceptionally large share of industrial sales within the Company's retail sales mix, and the concentration of those sales in a relatively small number of large customers.

3. The Characterization of Forecast Bias by OES Has No Foundation.

For the reasons discussed below, Mr. Heinen's assertions that Minnesota Power's forecast is biased downward has no analytical basis. Heinen confuses forecast error with forecast bias. Forecast error is, of course, inherent to forecasts of all types and is unavoidable.

4. OES Incorrectly Applies Weather Coefficients.

Mr. Heinen utilizes Minnesota Power's estimates of weather effects, as represented by weather coefficients, to simulate the impact of normal weather on calendar month sales. However, the weather coefficients estimated by the Company are determined by regressing monthly *billed* energy, not *calendar* month energy, on weather and other variables. The Company's models necessarily include weather for the current and the immediately preceding months. In contrast, calendar month consumption is a function of weather in the current month, where the impact of weather of the previous month is inconsequential or small. Mr. Heinen's approach is conceptually inappropriate.

5. Alternative Sales Projections by OES Are Overstated and Provide No Value to the Commission in the Immediate Proceeding.

Mr. Heinen incorrectly utilizes key elements of the Company's monthly forecast process and, in the absence of calibration to long-term projections of fundamental economic drivers contained in the AFR, may overstate sales levels during the timeframe over which the new rates are likely to be in place. The projected billing determinants proposed by Mr. Heinen selectively focus on weather impacts and do not adequately account for future levels of fundamental forecast drivers, likely macro economic events in particular.

II. MINNESOTA POWER'S LOAD FORECASTING PROCESS

Q. Please describe the purpose of the Company's Advance Forecast Report.

A. Minnesota Power's load and energy forecast, as contained in the Annual Forecast Report or AFR, provides the basis for the Company to determine its future needs for capacity and energy involving the least-cost mix of generation resources, including off-system purchases. Importantly, the forecast is also a key input into the Company's near- and long-term financial outlook which includes projections of revenue, operating expenses, fuel charges, and capital expenditures. From time to time, the AFR provides the basis for the Company's presentation of billing determinants in rate case

filings before the Minnesota Commission. The AFR is presented in a highly transparent package of documentation, which is submitted to the OES and the Commission. This detailed fifty-page review is complemented by appendices that provide information of a subsidiary nature.

Q. Please describe the forecasting process used to develop the AFR.

A. The Company's forecast methods represent a complete and integrated process that utilizes data and information from a broad range of sources. Electricity consumption is determined by fundamental factors including the level of regional economic activity, weather, demographic information, appliance saturation data, and the real prices for forms of energy, including both electricity and substitute sources such as natural gas. The Company's forecast process begins by gathering and formatting data that represent and characterize these fundamentals. Where necessary, historical and exogenous forecast data, such as the effects of economic expansions, are developed through model simulation or are obtained through surveys of customers, as in the case of appliance saturation data.

Based on these data, Minnesota Power's forecasters develop sixteen econometric forecast equations. These forecast equations—*i.e.*, models—are specific to the Company's customer classes and sales categories, and include both customer models and energy models. The Company's forecast models are developed on a data base that reaches back to 1965 and contains over 100 variables covering metrics that describe economic output—*e.g.*, gross regional product, employment, real output in key manufacturing sectors (mining, taconite, pulp and paper, wood products)—personal and per capita income, demographics (population, households), real prices of fuels, weather, and electricity consumption.

Theory and intuition do not always provide insight regarding the structural form in which inputs—*i.e.*, exogenous independent variables—should enter the statistical models. The current form of the variables and the structure of the models—*i.e.*, model specification—represents the culmination of Minnesota Power's modeling experience over a number of years.

Accordingly, the form of independent variables that appear in the several equations varies appropriately from one sector to another. An immediate example is weather data, which are incorporated into the models in various ways, depending on equation and sector.

Q. Please describe the role of the annual forecast in Minnesota Power's forecasting process.

A. The central forecast result is the annual forecast of sector sales, which is determined using the structural models. The models are used to estimate the underlying relationship between the numbers of customers and energy sales for each sector, where the left-hand-side ("lhs") dependent variables (customers, sales) are explained by the appropriate right-hand-side ("rhs") independent or explanatory variables. The explanatory variables of the rhs are descriptions of the fundamental factors mentioned above and vary, in definition and in geographical coverage, from one equation to another.

The models themselves are in the form of estimated time series econometric equations, covering the relevant right-hand-side explanatory variables of interest. The models incorporate moving average and autoregressive terms of the appropriate order, which is specific to each of the equations, where appropriate. The rhs terms of the Company's forecast equations have consistently correct signs.

In several ways, the Company's forecast process obtains integrated forecast solutions. First, the AFR process utilizes a sophisticated general equilibrium model solution for future states of the regional economy served by the Company. Second, through simulation of the regional model, the Company solves for the net economic impacts on the regional economy that result from actions by large power customers and, implicitly, commercial and industrial customers at large. These impacts are manifested in changes in economy-wide metrics (employment, personal income, etc.) that, in turn, are used within the energy equations, as discussed above. Third, the Company incorporates the impacts of energy prices on sales, although without a simultaneous loop (solution).

Q. Please describe the role of monthly forecasts in Minnesota Power's forecasting process.

A. A subsidiary set of monthly models is utilized to estimate monthly energy sales that, in turn, are used to determine the shares of annual energy attributable to each month within the immediate forward year. This second-order process is straightforward, involving the calibration of the forecasts of monthly energy sales by class, to conform to the annual forecast result embodied in the AFR.

The annual model develops an explicit understanding of consumption via analysis of the key sectors of Minnesota Power's service territory, and the linkages of these export sectors to the regional economy. The monthly forecast models assume a somewhat different structure in view of the limits of data at the monthly level of frequency. Accordingly, monthly forecasts rely heavily on binary variables that identify months, weather variables, and autoregressive and moving average processes. This is entirely appropriate insofar as the purpose of the monthly approach is only to determine the monthly shares of annual energy.

Q. Do you agree with Mr. Heinen's characterization of Minnesota Power's forecasting process as lacking precision?

A. No. Minnesota Power's forecast is sufficiently granular in key dimensions, including sector definition and depth, time, and space. Specifically, the Company's forecasters model six customer groups/classes including the categories of residential, commercial, large industrial, lighting, public authorities (covering eighteen full and partial requirements customers), and sales for resale. As mentioned above, an unusually large share of the Company's sales are to large industrial manufacturing facilities situated within Minnesota Power's service territory covering the relevant region in Northeast Minnesota. For this class, the Company draws upon information gathered through direct contact with individual customers. These data, as we allude to above, are then incorporated into the forecast using regional macroeconomic simulation model tools of Regional Economic Models Inc.

("REMI"). This approach provides the Company with the means to determine the net impact on sales, including the direct sales to the individual customers undergoing plant expansion (contraction), as well as the induced, indirect impacts on the regional economy served by Minnesota Power's electricity sales.

Moreover, the Company forecast process is specific to the thirteen counties within which its service territory is for the most part contained. As noted above, Minnesota Power's approach separately identifies and models electricity energy consumption of the customer groups served by the Company according to monthly and annual timeframes (frequency), where the monthly analysis is utilized to determine the monthly energy shares for the immediate forward year, for the purpose of the financial outlook and budget.

Q. How does Minnesota Power's forecasting process compare to the methods utilized by other electricity service providers?

A. The Company's forecast methodology is highly developed. The Company pays attention to the details in its development of data, draws upon a variety of information inputs, goes to considerable lengths to understand forecast uncertainty and risks, and obtains a highly integrated forecast result.

The Company serves a comparatively small region of northeast Minnesota characterized by a unique base of economic activity, including unusually high levels of exports of manufactured goods. Aside from the comparatively high level of retail market risk facing the Company, this unique base of activity limits the availability of reliable data describing month-to-month economic activity. Key monthly data of economic activity at the county level are available (observed) on an annual basis only. Because economic activity is the main determining factor for future sales levels, and because data regarding the economy are only observed annually at the county level, the Company develops its forecast on an annual basis. In short, the Company's approach employs the only reliable data available for its service territory.

The Company financial outlook, as we mention above, requires the distribution of annual class energy sales among months, for the near-term

budget. Consequently, the Company applies a monthly modeling approach for the exclusive and limited application of creating a monthly sales profile for budget purposes. For its financial budget, the Company prepares a monthly forecast separately from the annual forecast and then calibrates the annual total across months to the AFR.

Q. What is your view regarding the Company's approach to determining future levels of load and energy?

A. The Company's load and energy forecast approach is complete, articulate, and viable. Forecasters at Minnesota Power draw upon and apply modern statistical analysis and tools. As I mention above, the forecasters utilize a broad range of data, and incorporate a consensus view regarding future levels of economic activity at national and regional levels. The Company is involved in various forums for regional economic modeling and electric energy forecasting.

I am impressed by the attention to detail in the development of data and information inputs—in particular, the gathering and use of customer-specific information for the large industrial customers served by Minnesota Power. The models exhibit good statistical performance and are reliable. The Company's overall forecast approach comes to grips with and manages key aspects and analysis and data constraints inherent to its business and market context, including a) a comparatively small-sized region comprised of several counties, and b) unusually large industry customers that contribute to inherent forecast risk that, as we mention above, the Company mitigates through its close contact and detailed understanding of individual large power customers. As described, these two factors are manifested in data constraints that, in turn, delimit the forecast methodology options available to the Company.

Q. Can the Commission rely on the Company's projections of billing determinants for the purpose of setting retail prices in the current docket?

A. A. Yes, absolutely. The accuracy of the Company's load and energy forecasting process can be gauged through assessment of forecast error over

recent years. Camfield Exhibit 1 presents forecast error for the Company's budget forecast, reaching back over a number of years. As shown, error is measured as the average percent difference between the forecast and actual sales levels for the forward year, and root mean square error ("RMSE") over the years. For reference, the annual forecast (AFR) for the more recent years is also presented.

As shown, the overall forecast performance of 0.29%, which is used for purposes of determining the Company's financial budget as well as for the immediate rate case filing before the Commission, is remarkably good. I highlight two observations, as follows:

a) while overall forecast performance is favorable, forecast error is noticeably reduced within the recent 2006 – 2007 timeframe, for both the budget—which contains the estimated impacts of unbilled energy—as well as the AFR.

b) forecast error declines when the national and regional economies are in a more-or-less steady state of growth, measured as the rate of change in real economic activity. However, transition periods, where economic activity is accelerating or slowing, are more difficult, leading to larger forecast errors. Arguably, a transition period describes the Company's business context during the 2003—2004 timeframe, where larger forecast errors are observed.

In summary, the Company's overall forecast performance, particularly for the energy sales used to determine the financial budget and to set retail prices, are highly reliable and should be used exclusively by the Commission in the current rate setting process.

IV. RESPONSE TO OES CRITICISMS OF MINNESOTA POWER'S LOAD FORECASTING

Q. Mr. Heinen observes that the Company's forecast values from the annual forecast, especially those of the residential class, appear to be too low. Do you agree with this assessment?

A. No. The overall forecast error comes about as a result of error in the estimated equations (coefficients), sometimes referred to as model error, and error in the projections of the exogenous forecast drivers including the effects of weather, which occur randomly. Together, these two factors determine overall out-of-sample forecast error. There is no evidence that the AFR-based forecast understates the overall sales level over the years that the Company's forecast models were estimated.

The exogenous forecast inputs, referred to above as the fundamental factors, are generated by objective, uninterested outside parties and include both published and private data sources. Accordingly, there is no basis to assert that such projections are systematically understated.

The forecast will of course contain some level of error, and my concern is that the Company's forecast may overstate sales over the near term in view of the current regional and national outlook. More specifically, the Company's projections for macro economic drivers, as utilized in the most recent AFR, are likely to be above near-term realizations.

Q. On page 15 of his testimony, Mr. Heinen states that his Table 1 shows that the AFR has a demonstrated bias toward under-forecasting sales. Does Table 1 demonstrate a bias?

A. No. Mr. Heinen confuses the concept of forecasting bias with forecasting error in his testimony.

Q. What is meant by the term forecasting bias?

A. Forecasting bias arises when the forecasting model regularly produces forecasts that are either higher or lower than the forecasted variable's actual values. In technical language, a forecasting model is biased when the expected value of the forecast does not equal the actual value.

Q. What is forecasting error?

A. Forecasting error concerns the outcome for a particular forecast or a particular set of forecasts. For example, Mr. Heinen's Table 1 shows that the AFR

forecasting model had forecasting error in 2007—which is inherent to all forecasts—but not necessarily forecast bias.

Q. Why doesn't the forecasting error in 2007 demonstrate forecasting bias?

A. All forecasting models have forecasting errors, regardless of whether they have forecasting bias. In order to determine the presence of bias, one would need to analyze the forecasts for a number of years. For unbiased forecasting models, one would see both over-predictions and under-predictions over those years, with the average forecasting error close to zero. For biased forecasting models, there would either be a predominance of over-predictions or a predominance of under-predictions, and the average error would be significantly different from zero. Mr. Heinen's analysis does not involve any demonstration of a consistent under-estimation of sales over a number of years that can only be explained by systemic forecasting bias. Mr. Heinen only utilizes a single year of comparison. In brief, the presence of forecast bias has not been demonstrated by Mr. Heinen.

Q. Would you please comment on Mr. Heinen's application of the Company's weather coefficients, as estimated within its monthly models?

A. To determine his alternative sales forecast, Mr. Heinen applies the Company's estimates of weather impacts, as represented by the weather coefficients of the Company's monthly model(s). For a specific month's impacts, the weather variables of these models cover the heating and cooling degree days for the current and most recent month. This is necessary because, for modeling purposes, the energy for the month is billed energy, representing energy consumption during the current month and immediately preceding month, which together can be referred to as periods *t* and *t-1*. Mr. Heinen inappropriately uses these estimated coefficients, as obtained for the current and *t-1* months, to determine calendar energy sales under normal weather conditions. This approach, with the level of detail provided in his testimony, is conceptually incorrect. Mr. Heinen should utilize within-month weather to explain sales for the month, as the effects of weather of the previous month has virtually no impact on current month results. No faith can be placed in

Mr. Heinen's challenge of Minnesota Power's annual sales forecasts when the challenge includes patently incorrect weather normalization data. The accuracy and credible methodology utilized by Minnesota Power as explained above would be more appropriate for determination of the sales forecast.

Q. Please comment on Mr. Heinen use of the average of prior year sales to determine the sales level in the next annual period, for large industrial customers.

A. Mr. Heinen's implicit random walk approach—*i.e.*, current and recent sales constitute the expected value of future sales—presumes that the information obtained through the Company's approach, which can be referred to as the customer contact approach, provides no additional information of value for the purpose of determining sales in the next period. This presumption is not only counter-intuitive, but also unsupported by an analysis of how the proposed random walk approach performs over a number of years in comparison to the direct contact approach. Comparing Minnesota Power's forecasting approach to Mr. Heinen's proposed methodology over a number of years shows that the Company's approach is far more accurate.

Year-Ahead Forecast Error (%) For the Industrial Customer Class		
Forecasts Year	Proposed OES Forecast Approach (Average of 3 Prior Years)	Minnesota Power Forecast (Customer Contact)
2003	-5.60%	1.05%
2004	5.20%	5.10%
2005	3.72%	0.88%
2006	3.32%	-0.34%
2007	-1.91%	3.72%
2008 YTD	2.26%	0.16%
Average (2003-2008)	1.16%	0.52%
Error Events >2% Magnitude	5	2
Error Events <1% Magnitude	0	3

As shown above, Minnesota Power's customer contact approach for the very largest industrial customers, which represent an overwhelming share of total industrial sales, appears to be substantially more accurate than average historical sales as proxy for next year's sales, as proposed by Mr. Heinen of OES. Indeed, the Company's forecasts are off by one-half of one percent. Also, similar relative error levels are obtained when viewed in terms of absolute percent error. Note, also, that for the LP class sales, which represent the dominant share of the Company's system loads, the errors are usually positive. This result is in sharp contrast to the alleged presence of negative bias and systematic understatement of sales.

In summary, Mr. Heinen's approach of averaging past sales, as a basis to develop projected sales to large industrial customers, appears to have no empirical foundation and thus provides no value to the Commission for the purpose of setting retail prices in the immediate docket. At the very least, such approach should not be adopted in absence of exploratory research grounded in empirical facts.

Q. Does this conclude your testimony.

A. Yes, it does.

Exhibit 1
MINNESOTA POWER COMPANY
MEASURES OF FORECAST ERROR*
(Budget and AFR)

	Average	2007	2006	2005	2004	2003	2002	2001	2000	
Budget	0.29%	-1.54%	-0.01%	0.83%	4.60%	4.20%	0.87%	-3.24%	3.56%	-
AFR	-1.14%	-2.12%	0.15%	n/a	n/a	n/a	n/a	n/a	n/a	

* Error measured as the deviations of the realizations (actuals) from forecast values. Budget values taken from MWh section of Schedule 3 SQD.