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Review of BC Hydro Electric Load Forecast Methodology
British Columbia Hydro and Power Authority

September 22, 2014

Disclaimer

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The information has been prepared and compiled to assist BCH in the analysis of their Site C 1,100 megawatt hydro facility. While the information is believed to be accurate, in preparation of the report, Gilbert has not independently verified any of the underlying input numbers themselves. Accordingly, Gilbert makes no representation or warranty as to the accuracy, reliability, or completeness of the information.

Executive Summary

Gilbert has conducted a review of the BCH Electric Load Forecast Methodology used in BCH's analysis of its proposed Site C 1,100 megawatt hydroelectric facility.

Gilbert has reviewed the BCH peak and sales forecasts and forecast methodology. Gilbert has also reviewed the company's documentation and responses to more than 60 questions posed to BCH personnel by Gilbert. A number of conference calls were made and emails were exchanged. Gilbert also met with BCH's load forecasting personnel at their Vancouver offices on September 16, 2014.

The BCH forecast methodology and process is representative of good utility practice. In particular, the company's forecast methodology for sales and peak are sound and useful for planning. The sales methodology is state-of-the-art. That methodology, known as Statistically Adjusted End-Use (SAE), is in widespread use as evidenced by reports by users at annual user group meetings facilitated by ITRON. While Gilbert has noted one potential improvement worth considering, the peak methodology is essentially state-of-the-art. Processes used by BCH's staff appeared to be effective and thorough.

Specific recommendations by Gilbert include the following. The company might consider enhancing the link between the SAE models and the peak forecast models or in the alternative study what the impacts of doing so might be. The company might also consider including scenarios for possible additional shale plays in the load forecast documentation due to the sheer size of impacts from such developments; however BCH does consider this in its 2013 Integrated Resource Plan (IRP).

The company's documentation is thorough. There are some terms used in the documentation which could be clarified in the glossary. A flowchart of the forecast process would also be useful.

Scope of Work

BCH has retained Mark P. Gilbert, LLC (Gilbert) to conduct a review of the BCH Electric Load Forecast Methodology used to assist BCH in the analysis of its proposed Site C 1,100 megawatt hydroelectric facility. The facility is proposed to meet BCH's forecasted energy and capacity gaps between 2020 and 2028. BCH has asked for a review and expert opinion on the Load Forecast methodology.

The review shall include:
- The appropriateness of inputs used to develop the Load Forecast
- The forecasting models used
- The output document titled "Electric Load Forecast, Fiscal 2013 to Fiscal 2033, 2012 Forecast" dated December, 2012

The review does not include:
- Validation of input numbers
- Load forecast and Demand Side Management (DSM) integration

BCH requires the review to be completed by September 22, 2014.

Gilbert was to examine BCH's forecasting system for use of state-of-the-art methodology and their execution of that methodology as part of the total sales and peak forecast process. As well as answer questions like these: Has the company selected state-of-the-art modeling and methodology and does the company utilize that methodology adequately too ensure the best possible accuracy for purposes of planning? Does the company have a successful track record using this methodology?

In Gilbert's 30+ years of experience using models for forecasting (see Appendix A), it's clear that models do not fit every situation that a company faces and can't always accomplish everything the company wants to accomplish. One of the things that Gilbert looked for is how the company has dealt with those situations that make it difficult to use a model(s) or make the model difficult to apply to the circumstances that the company faces.

Discussion - Findings

Methodology-Sales

When it comes to best methodology, the phrase used most often is state-of-the-art. When it comes to state-of-the-art the company is in good shape. The company employs SAE models which are both state-of-the-art and cost-effective to implement. They also utilize the methodology of forecasting large loads individually using information gathered from the customer and from company customer service representatives in addition to third party consultants for specific sectors and other third party sources such as the BC Oil and Gas Commission.

The utility industry has been through substantial load forecasting methodological changes over the last 30 or more years. Econometric modeling was the state-of-the-art before the 1980s. Econometric modeling is generally thought to provide accuracy as long as the inputs are adequate. When there is structural change, econometric models can struggle to be accurate and even be difficult to use. The energy crisis of the 1970s and energy conservation ultimately resulted in a move toward end-use modeling to capture those structural changes. In the 1980s and 1990s, REEPS, COMMEND, INFORM, and HELM were popular. However after being in use for a decade, those models were not thought to be as accurate as hoped for. Additionally, many inputs were required and they were difficult to obtain. Those models were large black boxes and in retrospect they were too costly for the typical utility forecasting shop. SAE models came next which are a combination of both econometric and end use modeling. Those models required less information because they were built more simply than the end use models that preceded them. The econometric side of the model helped with accuracy while the end-use side of the model dealt with structural change.

BCH adopted the use of SAE models to forecast residential and commercial distribution sales in 2006. The company conducts regular appliance saturation surveys to back up the model.

As referenced above, BCH forecasts loads of large customers individually – another good utility practice. The industrial sector makes up 32% of BCH's total annual firm billed sales and 80% of industrial sales are at transmission voltage (large customer loads).

The load patterns for many large industrial customers are tied directly to their operating schedules. Having knowledge of these operating schedules can improve these load forecasts. What can be expected is that for every interval-metered customer, there is a story that explains their load history. Refer to:
https://www.itron.com/PublishedContent/Short-Term%20Forecasting%20in%20Retail%20Energy%20Markets_100643WP-02.pdf

The logic behind forecasting individually is easily illustrated. Assume customer A, a flat rolled glass plant, has three identical production lines of 6 MW. The total load at the plant is 18 MW. Each line is either running or it is not – there is no half load level since melting glass required a specific temperature. If we observe that customer A has consumed 18 MW of load (except for unplanned outages or retooling) last year, then the peak load this year will not increase. Peak load could decrease if there were either an outage of major duration or the customer was unable to sell its product and shut down one or more lines for a notable period of time.

Therefore, sensible forecasts of customer A's peak load in the coming year would not show a trend upward or even downward. Any change will be a step change coming from a major expansion (increase in load) or shutdown of one or more lines. Neither is a trend and this rules out a number of forecast methodologies including simple trending and simple econometrics. The best forecast will rely on the customer and market analysis. In my experience, the vast majority of large industrial customers are similar to the illustration above.

Finding: BCH is using state-of-the -art methodologies for forecasting sales.

Methodology-Peak

The BCH peak forecast process is bottom up and relies, in part, upon BCH's Distribution Planning Department. The company forecasts distribution load and transmission load separately and does so for each substation respectively. These are added together using coincidence factors.

The distribution forecasts are prepared by BCH's Distribution Planning Department. However, the load forecasting department provides the distribution planners a "guideline forecast" for each area of BCH's service territory. These guideline forecasts are prepared in part with BCH's internal econometric models. Inputs include items such as energy forecasts by voltage, and the number of electric vs. non electrically heated homes and area specific economic drivers. Distribution planners then develop their forecasts and subsequently meet with the forecasting group to reconcile their forecasts with the guideline forecast. The outcome is the distribution peak forecasts. BCH stated that the process takes the distribution planners four months of elapsed time.

To the extent BCH's management relies on the distribution substation forecasts as being objective work, it would be imperative to have controls in place to ensure the influence of the distribution planner does not lead to inflated distribution peak forecasts. Among the controls would be that the load forecasters have a large role and appropriate executive representation in the outcome of those forecasts. Gilbert found no evidence of bias; examining this was outside the scope of the contract with BCH which excluded governance issues. Gilbert understands that BCH has periodic load forecast audits.

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The load forecasting department develops the transmission peak forecast customer by customer. These are added together using appropriate coincidence and power factors.

Total system peak is the coincident sum of the distribution and transmission peaks, plus some miscellaneous items and losses.

On the question of whether BCH utilizes state-of-the-art to forecast peak, there are several points to be made. First, the industry has not really coalesced around a single method to forecast peak. In Gilbert's opinion, this is because there are several good options with each having strengths and weaknesses. Second, in the industry, peak forecasting research dollars have been coopted by energy traders, resources which might have been used for research into best peak forecasting practices. Third, organizationally, in the industry, the forecast of peak demand isn't consistently the job of the load forecasters. That is, some other departments either through inertia and tradition or other means, have retained some ownership or influence over the production of peak forecasts, and the methodology used by these other departments is unlikely to deal with state-of-the-art concerns of the forecasting department.

That all said, what is Gilbert's opinion of the company's peak demand forecast process? The process will produce accurate forecasts about ten years out. However, the process of producing peak forecasts and sales forecasts are not linked as directly as they could be, and could impact the second ten years of the 20 year forecast. The peak forecast does not fully utilize the sales forecast which was produced with state-of-the-art methods including SAE. Therefore, the impacts of trends in energy conservation and more are not directly accounted for in the forecast of peak demand. And lacking this link could mean the two forecasts are going down different paths in the longer run. The company might consider studying what this divergence could be.

Findings:
  1) **The company utilizes several methodologies to produce peak forecasts, all of which are among state-of-the-art methods.**
  2) **While the sales forecasts use the SAE models and thus gain the forecast knowledge of the impacts of changing shares and energy use of end-uses, this forecast knowledge is not explicitly being transferred to the forecast of peak. It is worth considering enhancing BCH's forecast process to enable an explicit link between the sales and peak forecast models.**

Accuracy

The starting point for assessing accuracy is a review of the load forecasting methodology. Gilbert's findings with respect to BCH's load forecasting methodology are set out above. However, if forecasters aren't careful, they can become so absorbed in their methodology that they forget they are supposed to be focused on accuracy as well.

BCH tracks forecast accuracy. One of the ways they track accuracy is through graphics comparing different vintages of BCH's load forecasts to actuals. Two such graphics were provided by BCH and are included as Appendix B. The first graphic shows the forecasts tracking actuals well except in the circumstances of major and unpredictable events such as the great recession of 2008. The second graphic shows how the great recession stands out as unusual. The graphic shows upper and lower bands at 10% and 90% levels. The actual peak loads fall outside the bands which equates to the actual peak loads being a rare occurrence.

This is consistent with Gilbert's experience at American Electric Power (AEP) and colleagues of other utilities as evidenced by discussions by colleagues attending professional group meetings including ITRON's SAE user group. It is not possible to predict booms and busts; rather load forecasts are more steady state. Likewise Gilbert has observed that major vendors of economic forecasts do not forecast booms and busts in such things as Gross Domestic Product.

Finding: The load forecasts track actuals well except in the circumstances of major and unpredictable events such as the great recession of 2008.

Documentation

The company's forecast documentation is well organized. The forecast is compared to the prior forecast and the causes for the changes clearly described. The changes in direction are explained. The methodology is clearly described. The document seems to be of reasonable scope. Subjects which need emphasis or further explanation are well handled in the appendices. The writing is at the proper level for a broad but educated audience.

As with many utility forecasting functions, BCH has adopted its own process to 'actify' the methodology (i.e., the process of introducing assumptions into the models). That said, while the actual process is explained, a flowchart of the process placed near the front of the document might be helpful. A simple flowchart was prepared by BCH at Gilbert's request and is included as Appendix C.

The company has developed some terminology to describe its processes. However, outside parties may struggle with BCH's internal terms and acronyms. Several of the terms are not defined in the glossary. The flowchart previously mentioned above would help with this, as would expanding the glossary.

BCH implemented SAE in 2006 and has shown examples of the explanatory and forecast value of SAE to BCH management. SAE models contain considerable end-use information. Gilbert believes that it would be appropriate to share some of the SAE end-use inputs and results in the documentation.

In the BCH load forecast, the Montney shale gas play is included because it is load served as part of BCH's Integrated System. The load forecast increases as a result. This is the only shale gas play included in the load forecast as the other ones are remote (i.e., several hundred miles away from BCH Integrated System) and are not assumed to be electrified in the mid-level load forecast. BCH should consider formally including additional shale plays into the load forecast documentation from the 2013 IRP scenario analysis.

Findings: The documentation of the load forecast is very good. A few minor additions might be considered by the company as described above.
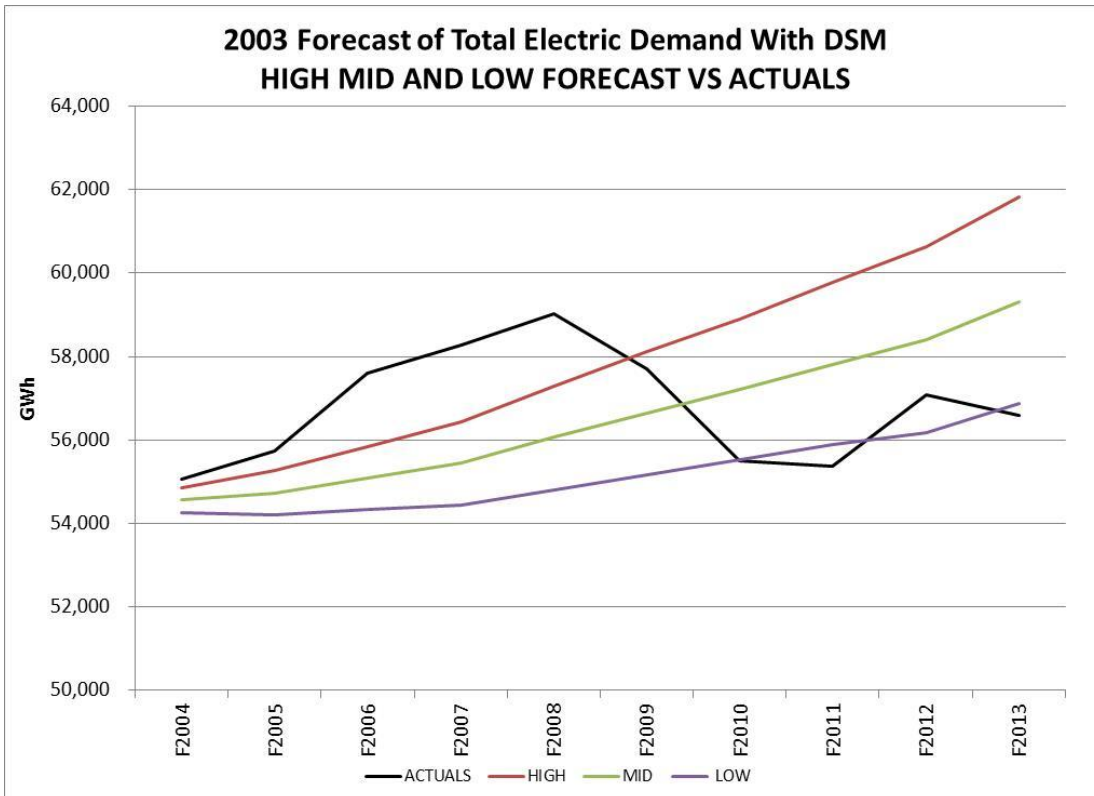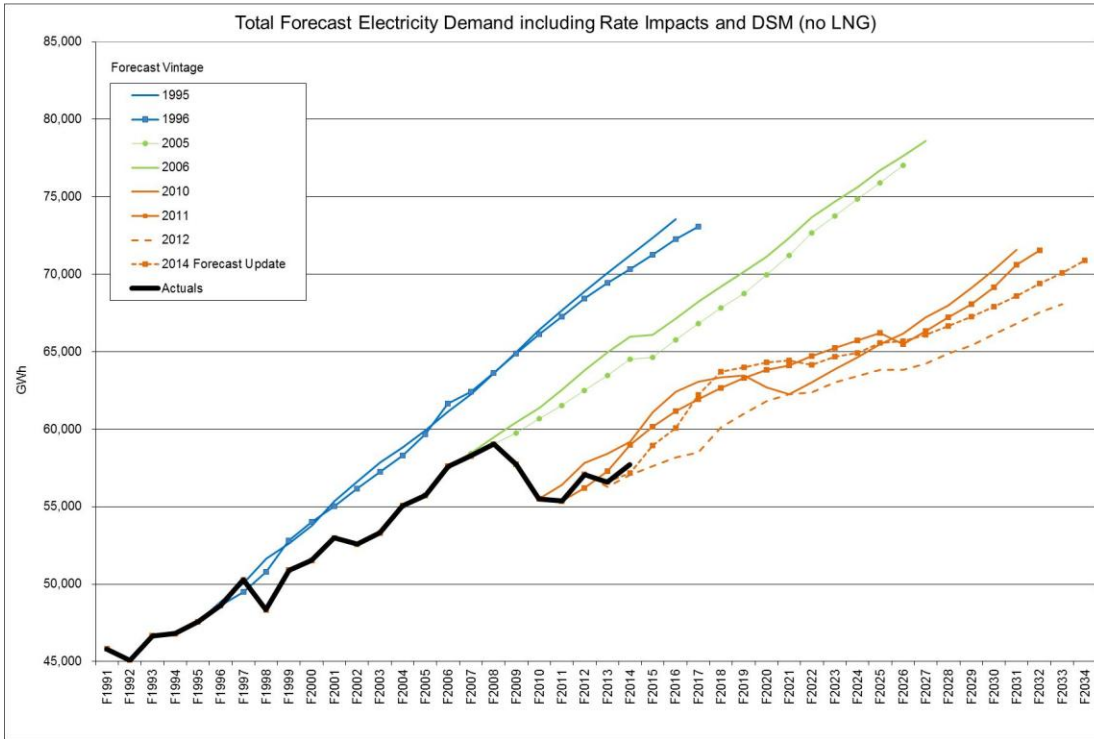
Appendix A

Mark P. Gilbert

Mr. Gilbert held the lead managerial or director position in forecasting at three electric utilities over a career of 33 years. The last 13 years were at AEP, which serves 5 million customers through seven electric operating companies doing business in 11 states and 16 jurisdictions. Shale gas extraction exists in four of these states. The sales mix of AEP is weighted slightly toward industrial with nearly a 40% retail share. Mr. Gilbert and his team produced 16 operating company jurisdictional forecasts each forecast cycle.

Over the span of his career, Mr. Gilbert built and forecast from modeling systems starting with econometric models, then large scale end use models (REEPS, COMMEND, INFORM, HELM), and finally SAE models.   He and the companies he worked for participated in the development of many of the models of the time as first users and beta testers and were active members of ITRON's Energy Forecast Group and Edison Electric Institute's Load Forecasting Group. AEP made for a good test case for new models due to its diversity of geography (Midwest, southwest, Texas Gulf coast), communities (urban, suburban, and rural), and climates.

Mr. Gilbert has prepared and filed testimony for his former employers over 30 times in his career, with most legal cases focusing on capacity and fuel requirements and related issues. In every application the load forecast was found to be acceptable for use in capacity planning.
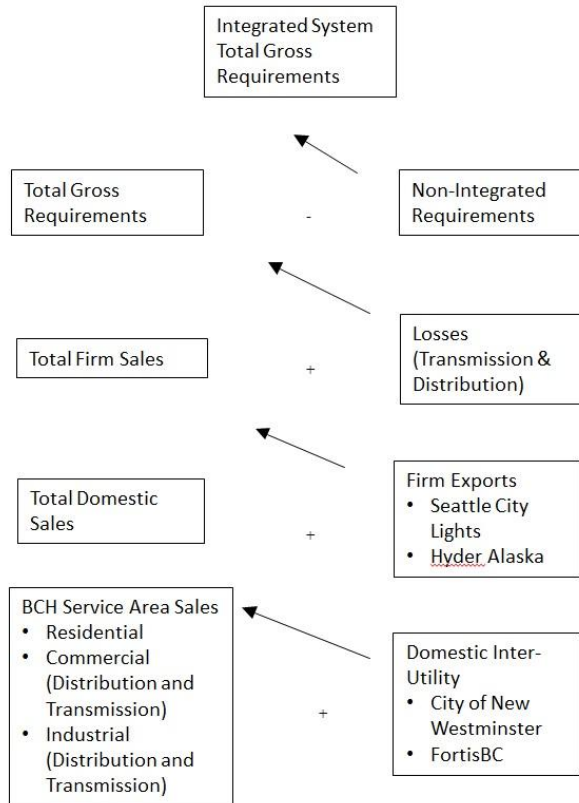
Appendix B

Provided by BCH

Total Forecast Electricity Demand including Rate Impacts and DSM (no LNG)

2003 Forecast of Total Electric Demand With DSM
HIGH MID AND LOW FORECAST VS ACTUALS

Appendix C

Provided by BCH

Integrated System Total Gross Requirements

Total Gross Requirements   -   Non-Integrated Requirements

Total Firm Sales   +   Losses (Transmission & Distribution)

Total Domestic Sales   +   Firm Exports
- Seattle City Lights
- Hyder Alaska

BCH Service Area Sales
- Residential
- Commercial (Distribution and Transmission)
- Industrial (Distribution and Transmission)

+   Domestic Inter-Utility
- City of New Westminster
- FortisBC

Note: Commercial Distribution includes commercial general, irrigation, street lighting and BCH Own Use. Forecast for commercial general and residential are developed using SAE.