Northwest Power and Conservation Council

March 14, 2007

MEMORANDUM

TO: The Power Committee

FROM: Massoud Jourabchi, Manager, Economic Analysis

SUBJECT: Application of Short-term Models for Resource Adequacy Analysis

At the February Power Committee meeting, I described the Council's new short-term load forecasting system and how it could be used to produce weather normalized load forecasts, or to explore the effects of extreme weather conditions on load. In the attached report, I present the application of the new model for resource adequacy analysis.

The new short-term demand forecasting models give the Council the ability to explore temporal patterns of demand during the hours of the week, and how these patterns can vary with extreme weather conditions. To be useful for the resource adequacy analysis, the load forecast needs to measure loads under different conditions. Different conditions can arise from different definitions of the sustained peaking period (SPP), different measurements of loads, and different levels of planning for adverse weather conditions.

The attached paper explores these three dimensions in detail. The resource adequacy technical committee is evaluating the dimensions of the SPP. Currently, the SPP is defined as a 50-hour weekday period. Our investigation of variations in this definition finds that if we include weekends in the SPP, loads can increase.

The degree to which we want to plan for adverse weather conditions also affects forecasted loads. We explored three adverse weather planning levels. We forecast load for extreme temperature conditions defined as a 1-in-79 year weather event. We also forecast load under average temperature conditions. For the resource adequacy analysis, a third planning measure, the top 5-percentile temperature condition, or a 1-in-20 year weather event, is used. The analytical framework used for this analysis is flexible and other adverse weather condition planning levels can be evaluated.

In the report, we present the current forecast for 2007-2010 under different measurements of load and for the three weather conditions. The report also shows a sensitivity test for the SPP definition. The analysis shows that care needs to be taken in defining the SPP. A well-defined SPP can help the region prepare for unexpected temperature extremes.

Application of Short-term Models to the Resource Adequacy Analysis

Background: In the last Power Committee meeting, I presented the methodology for the new short-term load forecasting model. We use an econometric approach to modeling hourly loads for the region. One advantage of the econometric modeling method is that it enables us to break down the regional load into temperature normalized loads, and loads that respond to deviations from normal temperatures. This useful feature of the model allows us to simulate loads under different historical weather conditions. This capability is important in planning for adequate resources in the region.

Application to the Resource Adequacy Analysis

In order to determine if the region has adequate resources, it is necessary to evaluate the ability of resources to meet loads under different possible weather conditions. To prepare hourly loads for use in the resource adequacy analysis, we needed to incorporate a few issues into our analysis. First, we need to know which hours to include or exclude from the analysis. Second, we need to know how load is measured. For example, is load measured as an average load over a given period or as a single-hour peak load? The third issue is the degree to which we are planning for adverse weather conditions. Are we planning to meet load under the most extreme weather conditions, or under normal weather conditions? These three concepts are expanded upon below.

1- Sustained Peaking Period (SPP)

Which hours to include or exclude from the resource adequacy analysis is determined by how we define the sustained peaking period (or SPP). The modeling framework is flexible in that it allows users to specify any combination of hours in a day, days in a week, or months throughout the year. In this report, we are using the SPP that is defined as a 50-hour weekday block of time. For winter months (November, December, January, February, March) the SPP is defined as two 5-hour periods per day over 5 days. The first period runs from 7 a.m. to 11 a.m., and the second period from 3 p.m. to 7 p.m. For all other months, SPP is defined as 10 consecutive hours per day starting at 10 a.m. and ending at 7 p.m. All weekend days are excluded from this definition of SPP. We selected these hours to cover the peak periods experienced in the region. By changing the definition of the SPP, we would also change our energy and capacity requirements.

2- Defining the Load Metrics

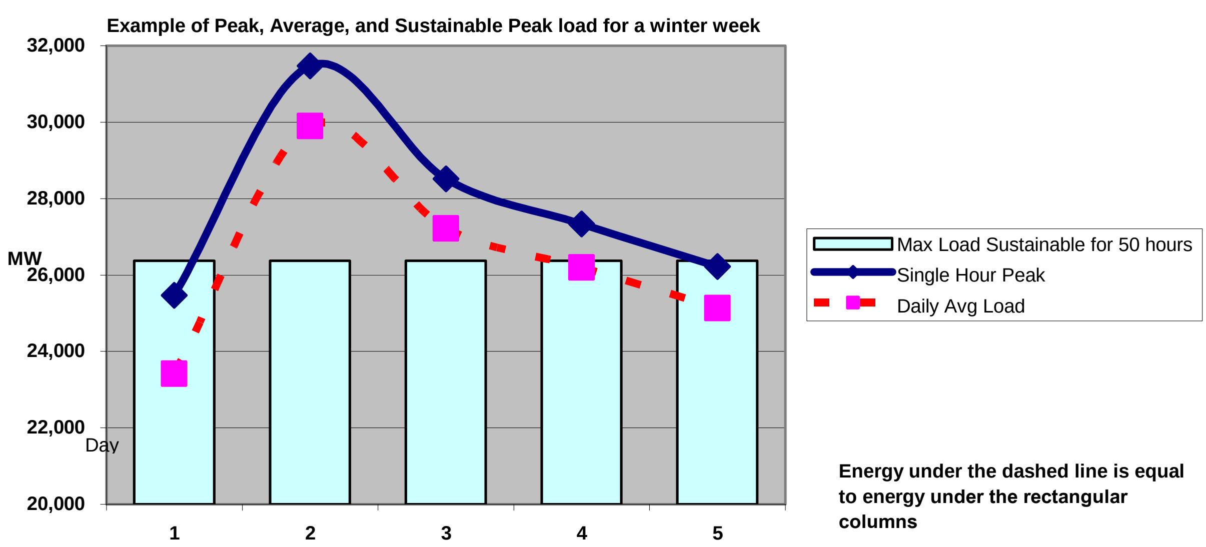
What load metrics we use for planning is the second issue we need to address. Planners in thermal-dominated systems, where the available capacity of the system is the constraining factor in meeting demand, are concerned about single-hour peak load. In a hydro-dominated system, where the availability of energy over a given period is the constraining factor, average loads are often used in determining the adequacy of resources. For this analysis, we have used a third measure, a hybrid measure of peak and energy constraints. Maximum sustainable load is defined as the highest average load that the system can meet during a predetermined period--in our case the SPP. To clarify these three concepts, the following example uses regional loads during a typical winter work week.

The graph shows the daily single-hour peak, the daily average load, and the maximum sustainable load for 5 weekdays. The top line represents the single-hour peak load during each day. Planning for the adequacy of resources in a thermal system would be concerned with these hourly peak loads. So, during the week illustrated in the graph, the thermal system would be concerned with meeting the peak load for the week, 31,500 megawatts, which occurs on the second day. If the thermal system can meet this peak load, it also can meet the load requirements for other hours.

The dashed-lined represents the average load during each day. Planning for resource adequacy in a hydro-dominated system would be concerned with the sum of energy used during the five days. The hydro flexibility allows the system to meet average daily loads, shown as a dashed line, varying from 23,500 average megawatts to 30,000 average megawatts. Total energy during the 50-hour period is 1,318.75 gigawatt-hours. Although the hydro system can meet the peak hourly loads, it cannot meet peak loads indefinitely due to limitations on the amount of water available.

The maximum sustainable load, 26,375 average megawatts shown as equal-sized columns, , is the maximum average daily load that would exhaust the 1,318 gigawatt-hours of energy over the 50 hours.

We calculate these three measures of load for each sustained peaking period over the course of a month and year.



3- Planning for Adverse Weather

The third factor that needs to be addressed is the level of adversity in weather we want to plan for. Do we want to meet loads under the most extreme temperature conditions, or do we want to meet loads under average conditions? Planning for the most adverse weather conditions would require more resources. In this analysis, we report on three planning levels of weather adversity: an extreme temperature condition (or a 1-in-79 year weather event); average temperature conditions; and a 1-in-20 year weather event.

Forecasts Under Different Adverse Weather Conditions

Using the definitions developed for the sustained peaking period, the three ways of measuring loads, and the three levels of planning for weather adversity, we forecast monthly loads for the region. The methodology is as follows. For each day in the forecast period, hourly loads are weighted by their respective SPP weights. The SPP weight is either 0, to exclude that hour's load from the analysis, or 1, to include it in the analysis. The single-hour peak load and the average energy loads for the qualified hours are determined. Daily loads are aggregated for the SPP period to get the peak load and energy for the SPP. Weekly SPP loads are aggregated for each month to estimate the monthly peak, the monthly maximum sustainable (SPP) load and the monthly average loads.

For each month, the monthly single-hour peak load, monthly average energy, and monthly maximum SPP load is determined. For each month of the forecast period, each one of these three load measures has 79 values, corresponding to the past 79 years of weather experience in the region. For each one of the load measures, the 79 values are ranked in descending order. For each month, we select loads ranked 1^{st}, 4^{th}, and 39^{th}. A ranking of 1^{st} indicates the load corresponding to the worst weather that the region has experienced in the past 79 years. A ranking of 4^{th} indicates load corresponding to a 1-in-20 year weather event. A ranking of 39^{th} indicates load corresponding to a 1-in-2 year weather event (average temperatures). In the tables on the following page, we present the single-hour peak, the average monthly load, and the maximum sustainable (SPP) load for each month for 2007 and 2010, and for the three levels of adverse weather events. Loads presented in the table are net-loads, regional loads net of DSI load.

2007 and 2010 Regional net-Load with Various Weather Conditions

2007 1 in 79 year Weather Event			
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	36,506	30,561	32,895
February	36,357	27,216	33,928
March	29,990	24,086	26,766
April	25,406	21,856	22,501
May	23,842	21,081	21,600
June	25,694	22,494	23,983
July	27,295	23,687	25,162
August	26,205	23,446	24,714
September	23,443	21,262	22,066
October	28,863	21,781	22,443
November	37,593	27,259	33,124
December	37,102	27,854	31,744

2010 1 in 79 year Weather Event			
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	36,688	30,206	32,521
February	36,267	27,852	31,987
March	31,146	24,767	27,177
April	27,394	22,122	25,035
May	24,159	21,400	22,016
June	25,986	22,959	24,778
July	27,513	24,237	25,437
August	26,882	23,937	25,022
September	24,209	21,754	23,254
October	27,173	22,174	24,057
November	36,882	27,362	32,283
December	37,699	28,723	33,717

	2007 Average Weather Conditions		
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	30,726	25,620	27,051
February	28,261	24,612	25,826
March	26,988	22,914	24,022
April	23,999	20,871	21,379
May	22,795	20,719	21,019
June	23,716	22,043	22,680
July	25,202	23,100	23,767
August	24,611	22,556	23,378
September	22,427	21,079	21,422
October	24,066	21,091	21,457
November	27,664	23,787	24,951
December	29,787	25,895	27,010

2010 Average Weather Conditions			
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	30,544	26,108	27,879
February	28,763	25,040	25,892
March	27,140	23,350	24,456
April	24,540	21,290	22,168
May	23,344	21,128	21,558
June	24,343	22,467	22,850
July	25,524	23,568	24,228
August	25,058	23,006	23,648
September	22,926	21,545	22,301
October	24,258	21,510	22,157
November	28,049	24,003	24,950
December	30,291	26,267	27,590

	2007 1 in 20 Weather Event		
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	35,522	29,094	31,371
February	32,468	26,506	29,625
March	29,369	23,660	25,834
April	25,196	21,363	22,176
May	23,593	20,980	21,540
June	24,790	22,340	23,369
July	26,356	23,599	24,869
August	25,622	23,112	24,313
September	23,194	21,219	21,786
October	26,193	21,609	22,402
November	31,030	24,800	27,431
December	35,262	27,603	30,159

	2010 1 in 20 Weather Event		
	Peak Load	Average Load	Maximum Sustainable Load
	MW	MWa	MWa
January	35,745	29,831	32,190
February	33,578	27,374	29,847
March	29,538	24,077	26,475
April	25,624	21,928	23,159
May	23,964	21,352	21,853
June	25,437	22,755	23,610
July	26,863	24,175	25,215
August	26,140	23,649	24,585
September	23,643	21,693	22,907
October	26,089	22,072	23,380
November	31,984	25,267	27,846
December	37,187	27,884	31,643

Sensitivity of Resource Adequacy to the Sustained Peaking Period Definition

In the aforementioned analysis, the definition of the sustained peaking period excluded weekends. Typically, weekend loads are lower than weekday loads. Consequently, weekends are not included in the SPP definition. To test the sensitivity of the forecast to changes in the SPP definition, we conducted a simple sensitivity analysis by including weekends in the SPP definition. The following tables show loads and change in loads for 2007 under the 1-in-20 year adverse weather planning assumption. We observe that:

- Single-hour peak monthly loads are unchanged, except in December when peak load increases by about 200 megawatts.
- The average load during the SPP decreases by between 312 and 602 average megawatts.
- The maximum of average load during the SPP increases by between 0 and 1,704 average megawatts, depending on the month. The largest increase occurs in December.

This sensitivity analysis reveals that although weekend loads are typically lower than weekday loads, the region could experience weather conditions that would increase the maximum sustainable load by as much as 1,700 average megawatts in December.

Impact of Inclusion of Weekends in the Sustained Peaking Period Definition

	2007 With 1 in 20 year event			Change due to Weekend inclusion		
	Peak Load	Average Load	Maximum Sustainable Load	Peak Load	Average Load	Maximum Sustainable Load
Weekends included	MW	MWa	MWa	MW	MWa	MWa
January	35,522	28,910	31,784	-	25	412
February	32,468	26,344	29,928	-	(526)	302
March	29,369	23,393	26,189	-	(474)	354
April	25,196	21,068	22,416	-	(312)	240
May	23,593	20,509	21,567	-	(515)	27
June	24,790	21,686	23,369	-	(422)	-
July	26,356	23,054	24,869	-	(574)	-
August	25,622	22,737	24,313	-	(372)	-
September	23,194	20,841	22,319	-	(378)	534
October	26,193	21,025	22,914	-	(348)	513
November	31,030	24,262	27,810	-	(475)	379
December	35,461	27,006	31,863	199	(602)	1,704

Conclusion: From this sensitivity analysis, we conclude that care should be taken in defining the sustained peaking period. A restricted definition of sustained peaking period can result in lower than required resources. By not including weekends in the sustained peaking period, the region may find itself short by 1,700 average megawatts during December.

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