

# WECC Power Supply Assessment

June 16, 2004

## **A. Executive Summary**

### Purpose and Methodology

The purpose of this report is to present the results of the power supply assessment that was conducted in May 2004. The studies cover the summer period from 2004 through 2013, and the winter period from 2004/05 through 2013/14.

The assessment utilized a deterministic approach in evaluating the power supply margin<sup>1</sup> in meeting the total peak demand (firm plus non-firm) requirements for the peak hour of the study month. Uncertainties associated with such factors as resource availability and seasonal demand variations were considered explicitly by running additional scenario cases. The primary input variations were:

- The peak demand escalation (the percent that the peak demand forecasts for each zone were increased to account for reserve requirements and uncertainties pertaining to the demand forecasts).
- The inclusion or exclusion of resource additions that are not committed<sup>2</sup>.
- The treatment of resource outages such as scheduled maintenance and forced outages.

The peak demands represent the control area expected demand forecasts (1-in-2 probability) for the study months, as reported in the 2004 Loads and Resources data submittals. It was assumed that the forecast monthly non-coincidental peak demands for each zone will occur at the same time (no diversity). The peak demand escalation was applied directly to the peak demand forecasts. For example, if the peak demand escalation for a summer scenario was 7%, the August peak demand forecast for each year was multiplied by a factor of 1.07. Peak demand escalation should not be confused with the load growth escalation that is already represented in the peak demand forecasts.

### Results

The results that are reported in this report are a measure of the amount of unused generation capacity (**power supply margin**) in each of the defined areas under the specified conditions. Generation and demand are assigned to the individual zones, but firm contracts between entities in different zones are not entered into the model. The model calculates the transfers between the zones based on the solution criteria and the provided transfer capabilities. A negative power supply margin for a zone or area is indicative of resource shortages and/or transmission constraints.

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<sup>1</sup> Supply margin is the amount of resource capability (including imports) in excess of the demand requirements.

<sup>2</sup> Committed resource additions are projects that are currently under construction or in startup.

The results of the base summer study case (scenario #1) indicate that power supplies in WECC should exceed demands through 2007, provided that conditions do not change beyond those studied. The study used a 7% demand escalation to evaluate whether generation resource margins were sufficient to cover such a contingency or other uncertainties that would necessitate use of additional resources. A 5% de-rate was applied to non-hydro generation (8% for CAISO and LADWP)<sup>3</sup> to simulate forced outages, and the hydro capacities were reduced to model an adverse hydro condition. Resources included all existing generation plus generation additions and retirements that are committed (additions that are currently under construction and retirements that have a high probability of occurring). The available resources were further reduced to reflect scheduled maintenance. The zonal transfer capabilities were set at the adverse OTC levels (transfer capabilities that may reasonably be expected to apply under simultaneous high seasonal transmission loading conditions).

Three additional summer scenarios were run as sensitivity studies with various combinations of generation and peak demand escalation. These other scenarios provide sensitivity analysis for higher peak demands and/or the addition of uncommitted resources. In the studies where deficiencies developed in later years, surplus capacity in the northwest was stranded by transmission constraints as depicted in the graphic on page 27.

Similar to the prior assessments, the studies identified a potential congestion problem in Northern California in August 2004. The upgrade of Path 15 in late 2004, together with the addition of planned generation between August 2004 and August 2005, alleviate the Path 15 congestion before August 2005. A restriction on the Pacific DC Intertie (PDCI) during the summer of 2004 did not significantly impact supply margins in Southern California.

A winter study case (scenario #6) was run using resource and demand data for January, and similar parameters to the base summer case. The adverse OTC transfer capabilities for winter conditions were used for this case. Under the conditions studied, the CFE-Mexico area showed a supply deficiency beginning in 2013.

#### Notable Changes

A new “Four Corners” zone was added to the topology for the model. Since this removed some generation resources from the New Mexico zone, additional forced transfers were added to model ownership transfers of plants in the new Four Corners zone.

The northwest Loads and Resources data that were previously reported by the Northwest Power Pool (NWPP) were reported this year by the individual control areas.

#### Qualifications

The assessment model is designed to measure the power supply margin based on forecasts of peak demands and seasonal resource capacity. While peak demand forecasts for several years into the future are readily available from the WECC control areas, the forecasts of resource additions are only accurate for a few years into the future. Therefore, the validity of the results

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<sup>3</sup> These utilities have suggested that older generating plants and more stringent environmental limits increase the likelihood for forced outages of non-hydro units physically located within their defined zones.

decreases the further out one looks over the assessment period. There is a point where the results shift from a determination of supply margin to a determination of future needs.

There is an important distinction between capacity and energy that must be considered, particularly for the northwest zone. While a peak capacity study such as is reported here may show surplus capacity in the northwest area, the capacity may not be available for a prolonged period due to the limited availability of water. The Reliability Subcommittee (RS) has formed a task force to develop a methodology for preparing an energy assessment that would help to evaluate the impact of adverse water conditions.

Although the power supply margin appears to be similar to an operating margin or planning margin, there is no direct association. The adjustments to generation and demand in this assessment are intended to model uncertainties associated with a power system. Many of the adjustments are not applicable when calculating an operating margin or a planning margin. A detailed breakdown of the adjustments is provided in this report at the end of the 'results' section.

A determination of a positive supply margin for a zone does not necessarily mean a positive margin for all demand centers within that zone. Transmission constraints internal to a zone may limit electricity transfers to local demand areas, leaving them without a positive margin. These transmission-constrained local demand areas may include one or more major metropolitan areas within a zone and may include most of the total population within a zone. WECC's seasonal assessments and Ten-Year Coordinated Plan Summaries address potential intra-zonal resource inadequacies based on information provided by representatives from the various areas.

#### Status of Recommended Enhancements

- Consistent 1-in-2 demand forecasts – control areas representing over 96% of the total demand have verified that they reported a 1-in-2 peak demand forecast.
- Temperature based extreme peak case – temperature sensitivity data was requested from each of 30 load-serving control areas. The weather data and methodology are expected to be in place in time for the Fall assessment.
- Probabilistic studies – the sensitivity factors to support probabilistic studies have not been requested from the WECC members. The Reliability Subcommittee has requested that the WECC staff experiment with probabilistic studies using some generic assumptions as time permits.
- Energy assessment – the Reliability Subcommittee (RS) has formed a task force to develop a methodology for preparing an energy assessment.

## **B. Introduction and Background**

The WECC Power Supply Assessments address the need to study the power supply margins on a Council-wide basis and to identify areas within WECC that have the potential for electricity supply shortages based on reported demand and resource data and considering transmission constraints between areas.

The WECC Reliability Subcommittee has the responsibility to establish the tools, methodology, and data requirements for conducting the power supply assessments. This responsibility is described in the attached document entitled “WECC Power Supply Assessment Policy.”

The WECC staff was given the assignment to use the WECC Loads and Resources (L&R) data as input for the California Energy Commission (CEC) model and utilize the model’s results to measure the power supply margin in the sub-areas or zones within the WECC.

## **C. Reserve Margin**

Reserve margin is a measure of the resource capability in excess of demand requirement. The industry commonly refers to two kinds of reserve margin, namely, operating reserve margin for day to day operations, and planning reserve margin for short or long term planning purposes. A planning reserve margin is generally higher than an operating reserve margin since it must account for all of the uncertainties. A planning reserve margin includes the margin for an operating reserve margin plus an additional margin for planning purposes.

The Minimum Operating Reliability Criteria Work Group (MORCWG) of WECC has defined an operating reserve requirement (operating reserve margin or contingency reserve) that requires a control area to maintain sufficient operating reserve as quoted below from the WECC Reliability Criteria Document.

“This Contingency Reserve shall be at least the greater of:

- (1) The loss of generating capacity due to forced outages of generation or transmission equipment that would result from the most severe single contingency (at least half of which must be spinning reserve); or
- (2) The sum of five percent of the load responsibility served by hydro generation and seven percent of the load responsibility served by thermal generation (at least half of which must be spinning reserve).”

WECC does not currently have a planning reserve margin requirement. However, the Power Supply Assessment Policy (see attachment 1) defines a requirement to “project whether enough resources exist, at any price, to meet load and possible reserves while considering the transmission transfer capabilities of major paths.” In the absence of a planning reserve margin requirement, this assessment provides a measure of resources against the predicted demands in

the form of “what-if” analyses for various demand scenarios and for various resource scenarios that include or do not include uncommitted resources.

The tables at the end of the ‘results’ section provide an estimation of a planning reserve margin for WECC overall, which includes resources that would be used for operating reserve. Note that the planning reserve margin shown in the ‘Base Capacity’ tables exclude other listed adjustments used in the individual scenarios. The values for an overall WECC reserve margin or resource margin are not necessarily representative of the margins in each zone or area as transmission constraints can limit the export capabilities from the zones with surplus resources.

The sum of the peak demand escalation and the forced outage rate provide a rough estimate of the amount of planning margin that is represented by each scenario. A demand escalation of 7% and a forced outage rate of 5% would approximate a planning margin of 12%.

## **D. Model Topology**

The topology of the CEC model is shown in the bubble diagram on page 8 (Bubble Diagram #1). The lines between zones are intended to represent transmission connections between the zones and the listed numbers are the transfer path capabilities as reported by the control area representatives. The model observes these maximum capabilities as it calculates the solutions for each scenario.

Transfer capabilities have been reported based on the following criteria:

- Maximum Transfer Capabilities are the rated path capabilities associated with ratings found in the WECC Path Rating Catalog.
- Nominal OTC Transfer Capabilities are the transfer limits used in day-to-day operations based on seasonal thermal and/or stability limits.
- Adverse OTC Transfer Capabilities are the limits that may reasonably be expected to apply under simultaneous high seasonal transmission loading conditions.

Only the Adverse OTC Transfer capabilities were used for this assessment. The values shown on Bubble Diagram #1 are the adverse OTC capabilities for the summer season (winter capabilities are represented in Bubble Diagram #2). The capabilities shown with yellow highlighting reflect changes in transfer capability during the study period (see list below). Transfers with other regional councils such as MAPP and SPP are ignored in this assessment, as this would require an assumption regarding the amount of surplus or deficit generation in those councils.

For this assessment, the following transfer capability changes (selected from the Phase 3 projects of the WECC Three-Phase Rating Process) were represented.

- Utah – Northern Nevada, new adverse OTC capability of 440 MW east to west (235 MW west to east) due to planned addition of Falcon-Gonder line, effective May 2004.
- California, Central – California, North, new adverse OTC capability of 5,000 MW south to north due to Path 15 upgrade, effective November 2004.

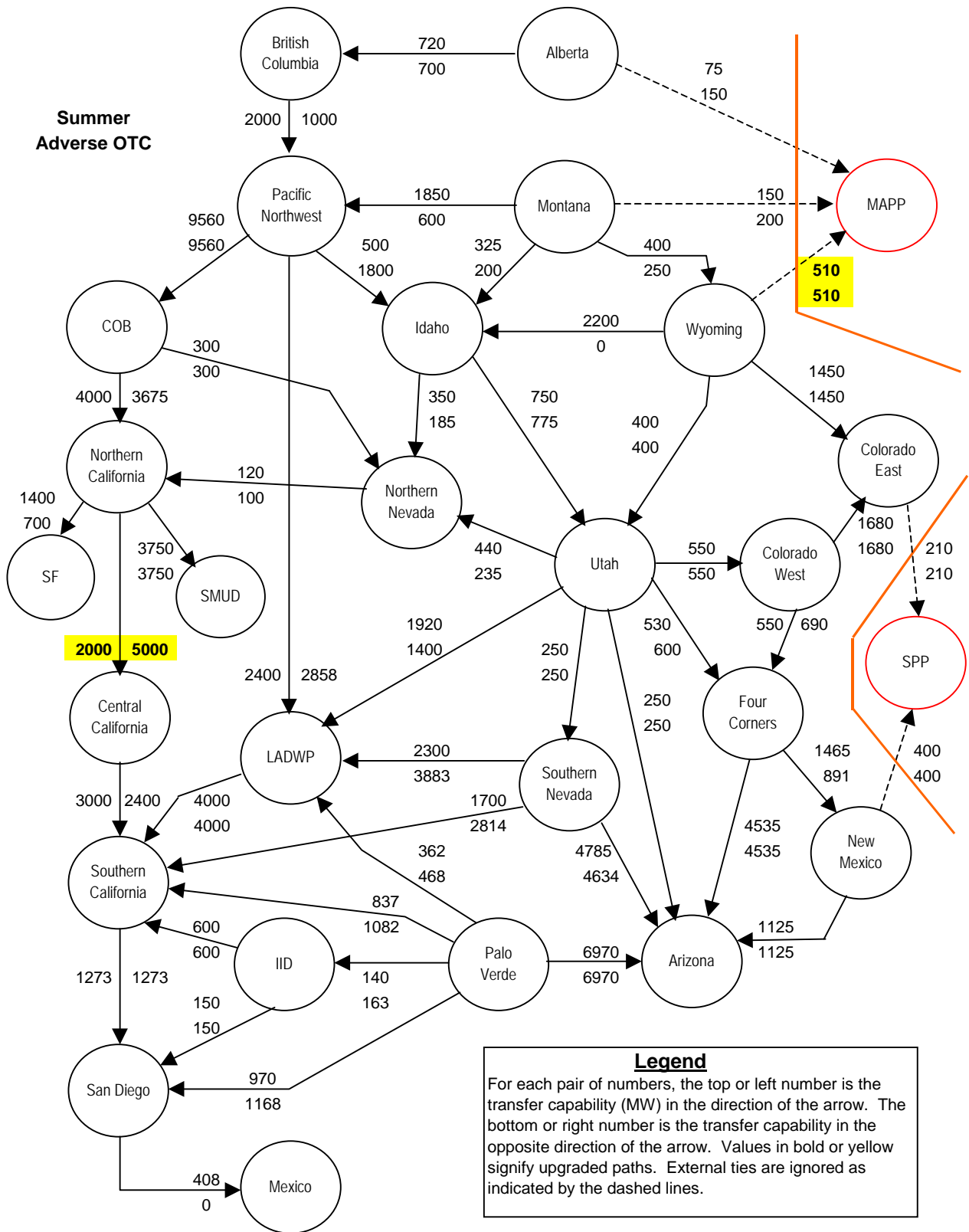
A limitation on the Pacific DC Intertie (PDCI) during 2004 was accounted for in the model. It was assumed that the line was back in service by January 2005.

## **E. Recommendations For Future Assessments**

1. The WECC member systems should continue to be involved in the verification of the data.
2. The effect of using non-coincidental demands should be examined. Preliminary studies indicate that the simultaneous combined peak demand for WECC has a variance of 1% to 3%, compared to the non-simultaneous demand. Work is underway to use temperature sensitivities to model an extreme, coincidental demand scenario.
3. The dynamic status of new generating plants in the WECC has introduced some additional uncertainty to the power supply assessment. The WECC members should be encouraged to provide information about planned resources in a timely manner to WECC for the purpose of conducting power supply assessments. Information regarding the retirement of existing units should also be provided. For merchant plants, the host control areas need to assume the responsibility for collecting and submitting the relevant data.
4. The hydro generation capability in the Northwest may have limitations beyond those assumed for this assessment. The seasonal operation of the coordinated hydro system is subject to dozens of parameters to accommodate the various interests in the river systems. If the effect of these factors can be determined, they should be addressed in future assessments.
5. Future plans for the model may include conducting probabilistic or stochastic studies to study the effects of random uncertainties. This would require that the members provide additional information such as resource forced outage rates, resource operating costs, demand variations, transmission loss data, and transmission wheeling costs.
6. Planned changes to the transfer path capabilities must be reflected in the model to accurately measure their effect on the results. Since they would usually directly affect the results, only changes that are highly probable should be taken into consideration.
7. The effects of fuel diversity and availability should be modeled in future assessments. The prevalence of natural gas fired generation in WECC has raised concerns about the interdependencies of gas and electricity. One or more scenarios should evaluate the impact of gas shortages due to pipeline interruptions or demand spikes.
8. The studies described in this report do not address the energy supply in WECC. While WECC recognizes the need for an assessment of energy supplies, it is expected that the data and manpower requirements would be significantly higher than for this peak hour assessment. A more sophisticated model would also be needed. Some of the concepts that would have to be addressed are:
  - What is the minimum time resolution that must be studied?

- What generation parameters would be required? Minimum and maximum hydro availability for each hour, each day, each week, and each month may be required. Emissions limitations should be taken into account. Economic dispatch and startup requirements should be addressed.
- The model would also need to consider interchange and transmission constraints.

# Bubble Diagram #1 – Zone Topology (Summer – Adverse OTC)



## F. Study Cases and Results

The criteria used in the study cases are summarized in the following table. Note that “additions” refers to generation additions and retirements.

Table #1 – Scenario Criteria

Criteria	Study Scenarios						
	#1	#2	#3	#4		#6	
<b>Generation</b>							
Existing as of 12/31/03	yes	yes	yes	yes		yes	
Committed Additions (units that are under construction)	all	all	all	all		all	
Uncommitted Additions (units that have not yet started construction)	no	yes	no	no		no	
Non-Hydro De-rate (%) to model forced outages *	5%	5%	5%	5%		5%	
L&R Sched. Maint. and Inoperable	yes	yes	yes	yes		yes	
Adverse Hydro de-rate	yes	yes	yes	yes		yes	
<b>Peak Demands</b>							
Peak Month	Aug	Aug	Aug	Aug		Jan	
Peak Demand Escalation (%)	7%	7%	12%	15%		7%	
<b>Transfer Capability</b>							
Maximum Path Rating	no	no	no	no		no	
Seasonal OTC Limit	no	no	no	no		no	
Adverse OTC Limit	yes	yes	yes	yes		yes	

\*The non-hydro de-rates were set at 8% for the following zones (due to age of plants and environmental issues): Northern California, Central California, Southern California, San Diego, San Francisco, and LADWP. See “Resource Adjustments” section for the restrictions used for hydro generation.

The following pages present the detailed results of each of the scenarios, including graphical representations of the annual supply margin by WECC area (areas are defined in Table #2). Note that the extent of the supply surplus or deficiency for a given area is subject to the inherent problems associated with the simplistic methodology. If multiple areas are in need of additional capacity, several factors may determine which area(s) get access to any surplus capacity. Generally, the model will make excess capacity available first to the deficit area that is closest to the surplus area.

Table #2 – Area definitions

Area	Zones in Area	Area	Zones in Area
Canada	Alberta, British Columbia	No. CA	Central CA, Northern CA, San Francisco, SMUD
Northwest	COB, Idaho, Montana, No. Nevada, Northwest, Utah	Desert SW	Arizona, IID, New Mexico, Four Corners, Palo Verde, So. Nevada
Rockies	Colorado-East, Colorado-West, Wyoming	So. CA/MX	CFE-Mexico, Southern CA, San Diego, LADWP

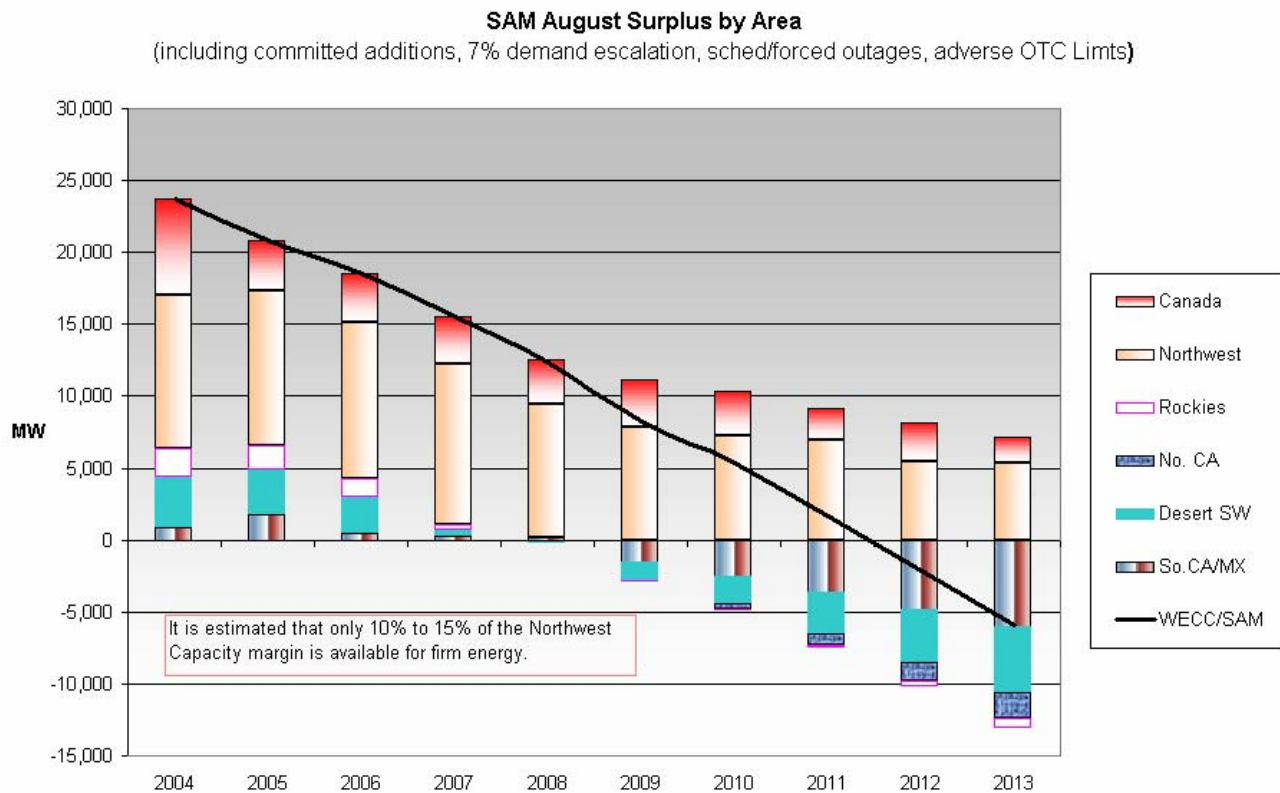
## Scenario #1 – Results

Criteria: August peak demands, 7% Peak Demand Escalation, Generation Additions reflect only those additions that are Committed<sup>4</sup>, Scheduled Outages & Inoperable, Non-hydro generating unit capabilities are derated by 5% (or 8% in California due to the age of the units and the more stringent environmental restrictions), Adverse Hydro, Adverse OTC limits.

The results of this case predict that under the studied conditions, power supplies in WECC will exceed demands through 2007. Beginning in 2008, transmission constraints prevent a surplus in the north (see north – south division in Bubble Diagram #3 on page 27) from reaching the deficit areas in the south. By 2012, the south deficit is larger than the north surplus, resulting in an overall deficiency for WECC.

The following graph presents the results by WECC area. When the surplus for an area is zero (0) and no bar is shown on the graph, the area is in resource/demand balance, or else it is importing to meet its demand.

Graph 1 - Scenario #1 Margin Graph



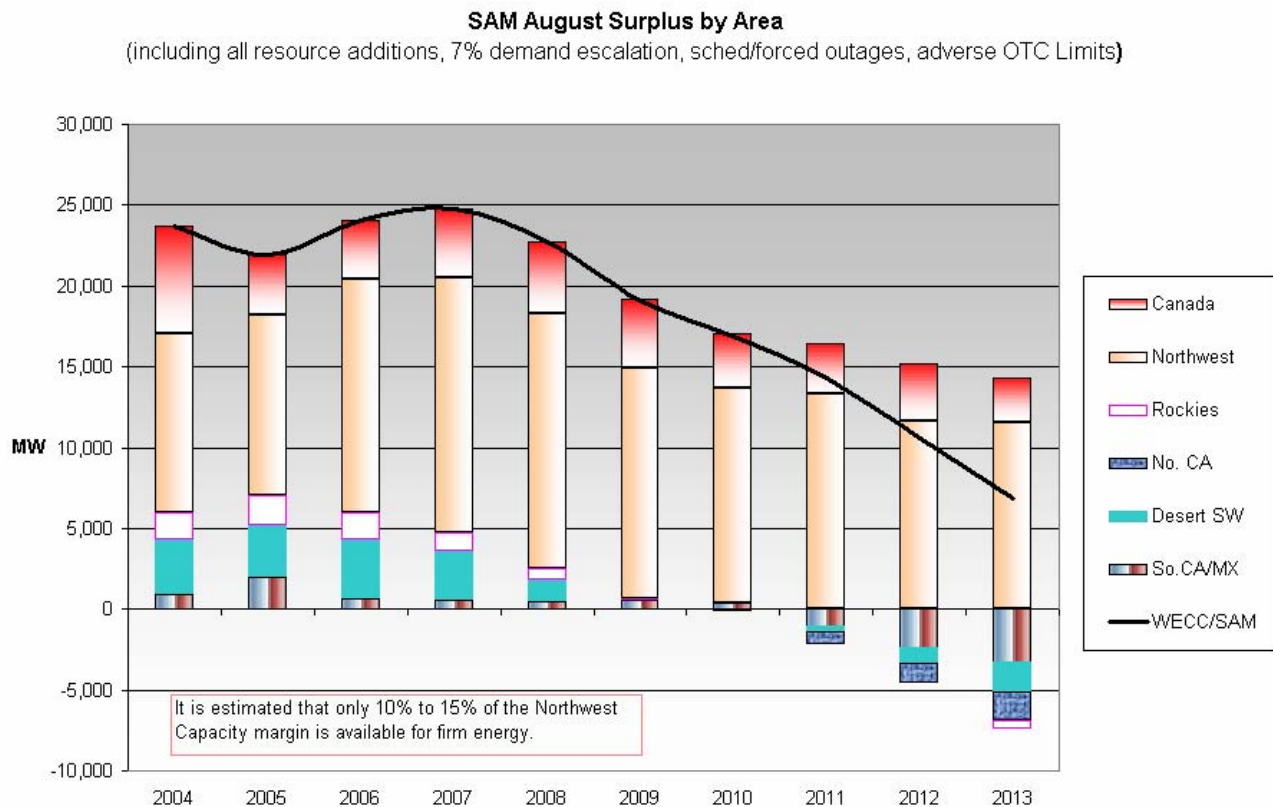
<sup>4</sup> Committed generation is generation that is currently in start-up or under construction.

## Scenario #2 – Results

Criteria: August peak demands, 7% Peak Demand Escalation, Generation Additions reflect all planned additions (Committed + Uncommitted), Scheduled Outages & Inoperable, Non-hydro generating unit capabilities are derated by 5% (or 8% in California due to the age of the units and the more stringent environmental restrictions), Adverse hydro, Adverse OTC limits.

The results of this case predict that with the inclusion of the uncommitted generation additions (see table #7) and under the studied conditions, area power supplies will exceed demands through 2010. Since the uncommitted additions have not started construction, there is a higher likelihood that a portion of them will be delayed or canceled. The following graph presents the results by WECC area.

Graph 2 - Scenario #2 Margin Graph



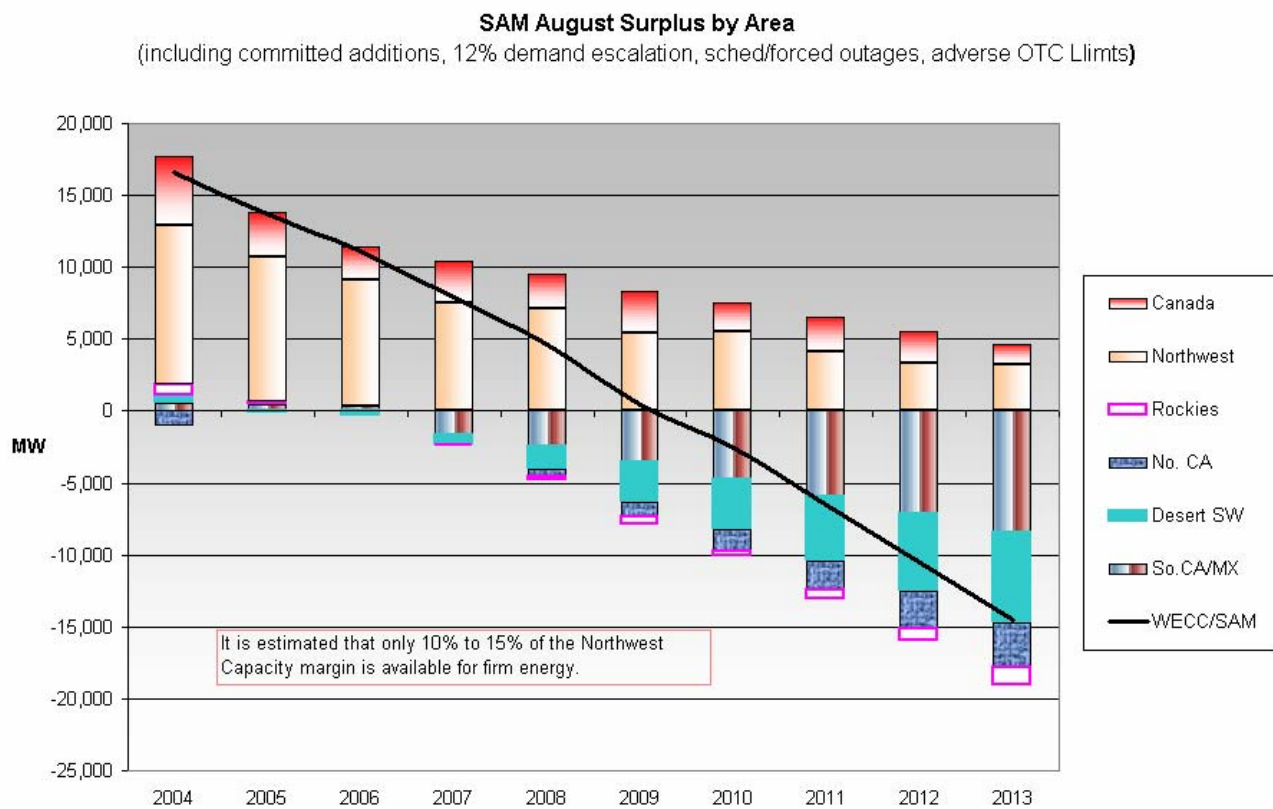
As described in the graph insert, only a portion of the Northwest capacity margin is available for firm energy. With the planned addition of uncommitted thermal generation in the Northwest, the amount of firm energy availability is higher here than in the previous scenario. Note also that the increased capacity from generation additions is partially offset by several planned retirements (see table #5).

### Scenario #3 – Results

Criteria: August peak demands, 12% Peak Demand Escalation, Generation Additions reflect only those additions that are Committed, Scheduled Outages & Inoperable, Non-hydro generating unit capabilities are derated by 5% (or 8% in California due to the age of the units and the more stringent environmental restrictions, Adverse hydro, Adverse OTC limits).

With a 12% peak demand escalation, a deficit condition occurs in 2004 for Northern California due to transmission constraints. This is alleviated in 2005 by the Path 15 upgrade and new generation additions. However, increasing demands create a north/south split (see Bubble Diagram #3) by 2006 to prevent a surplus in the north from reaching the deficit areas in the south. By 2010, the southern deficit is larger than the northern surplus, resulting in an overall deficiency for WECC. The following graph presents the results by WECC area.

Graph 3 - Scenario #3 Margin Graph

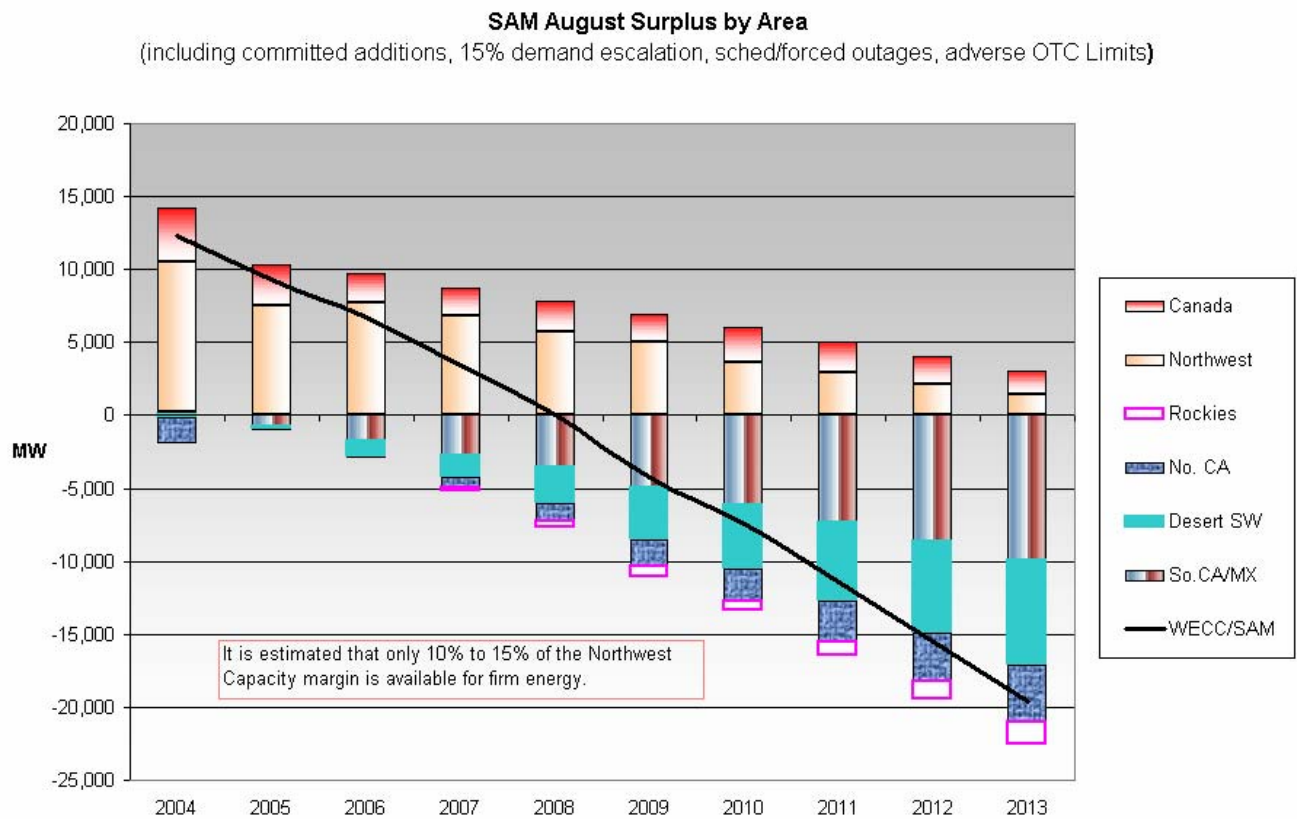


## Scenario #4 – Results

Criteria: August peak demands, 15% Peak Demand Escalation, Generation Additions reflect only those additions that are committed, Scheduled Outages & Inoperable, Non-hydro generating units are derated by 5% (or 8% in California due to the age of the units and the more stringent environmental restrictions), Adverse hydro, Adverse OTC limits.

With a 15% peak demand escalation, the same deficit condition described for scenario #3 occurred in 2004 for Northern California due to transmission constraints. This is alleviated in 2005 by the Path 15 upgrade and new generation additions. However, a deficit condition in Southern California and the Desert Southwest that also begins in 2004, continues throughout the study period. The familiar north/south split (see Bubble Diagram #3) prevents a surplus in the north from reaching the deficit areas in the south. By 2009, the southern deficit is larger than the northern surplus, resulting in an overall deficiency for WECC. The following graph presents the results by WECC area.

Graph 4 - Scenario #4 Margin Graph

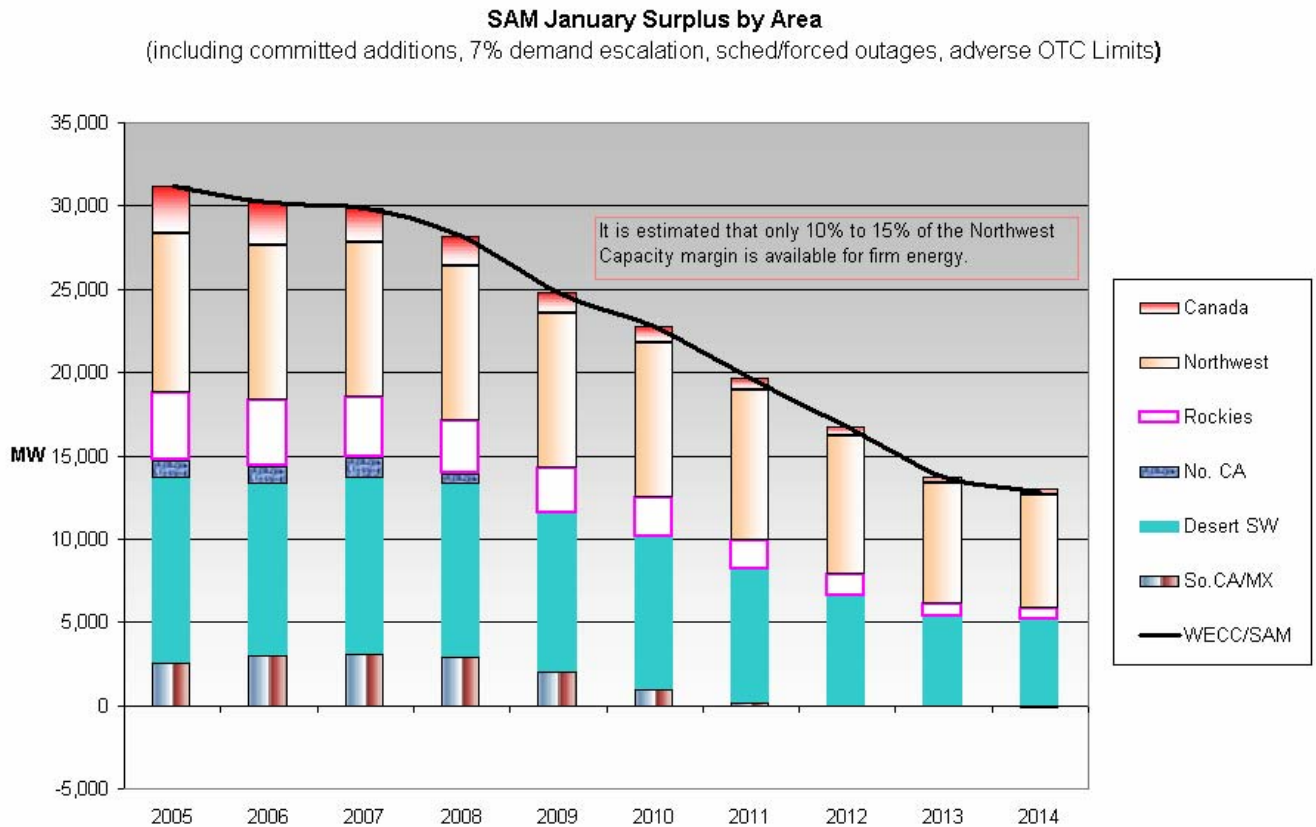


**Scenario #6 – Winter Results**

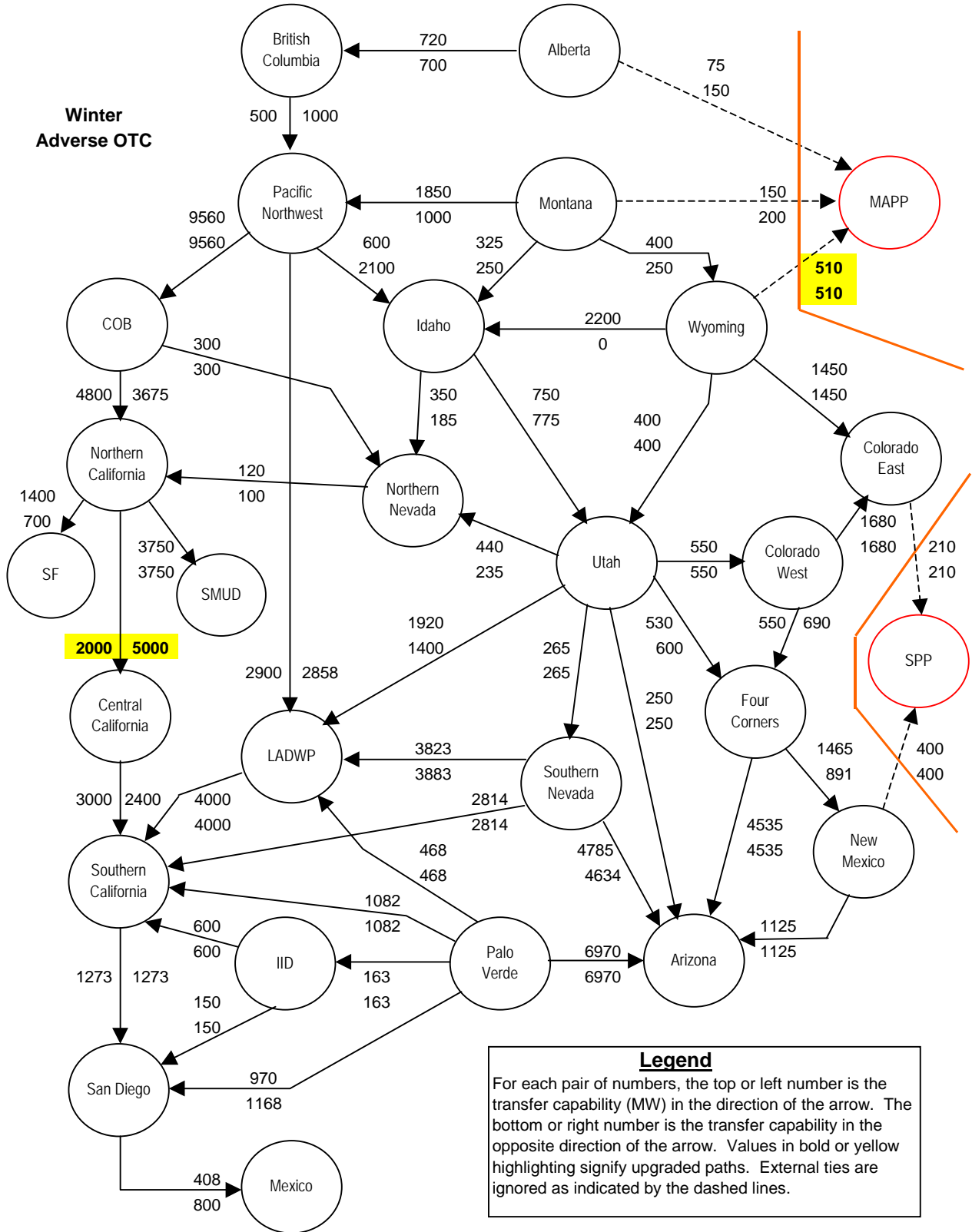
Criteria: January peak demands, 7% Peak Demand Escalation, Generation Additions reflect only those additions that are committed, Scheduled Outages & Inoperable, Non-hydro generating units are derated by 5% (or 8% in California due to the age of the units and the more stringent environmental restrictions), Adverse hydro, Adverse OTC limits.

The results of this case predict that under the studied conditions, winter power supplies in WECC will exceed demands through 2012 (winter is the December to February period). In 2013, a deficit developed in CFE-Mexico due to the path from San Diego to Mexico being fully loaded. The following graph presents the results by WECC area, and Bubble Diagram #2 represents the winter adverse OTC transfer capabilities.

**Graph 6 - Scenario #6 Margin Graph**



**Bubble Diagram #2 – Zone Topology (Winter – Adverse OTC)**



## Summary of Adjustments (August)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Base Capacity (August)</b>	(all values in megawatts unless otherwise designated)									
Total Unadjusted Committed Generation capacity	187,329	191,077	192,131	192,498	192,703	192,430	192,931	192,933	192,933	192,933
Adverse Hydro Derate	-3,429	-3,890	-3,871	-3,840	-3,812	-3,812	-3,812	-3,812	-3,812	-3,812
Total De-rated Generation	183,900	187,187	188,260	188,658	188,891	188,618	189,119	189,121	189,121	189,121
Total Unadjusted Demand	140,161	143,340	146,528	149,741	153,290	156,610	159,986	163,524	167,014	170,571
Estimated Planning Margin (%)*	31.2%	30.6%	28.5%	26.0%	23.2%	20.4%	18.2%	15.7%	13.2%	10.9%

\*Estimated Planning Margin (%) is (Total De-rated Generation - Total Unadjusted Demand) / Total Unadjusted Demand

### Scenario #1

Uncommitted Additions	0	0	0	0	0	0	0	0	0	0
Scheduled Maintenance	-1,332	-3,779	-3,713	-3,635	-3,155	-3,415	-3,155	-3,155	-3,155	-3,155
Forced Outages	-7,618	-7,828	-7,939	-7,969	-7,999	-7,945	-7,983	-7,983	-7,983	-7,983
Adjusted Generation Capacity	174,950	175,580	176,608	177,054	177,737	177,258	177,981	177,983	177,983	177,983
Demand Escalation (%)	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Escalated Demand + Losses	151,245	154,722	158,107	161,519	165,437	168,963	172,577	176,368	180,108	183,925
Resource Margin (MW)**	23,705	20,858	18,501	15,535	12,300	8,295	5,404	1,615	-2,125	-5,942
Resource Margin (%)	15.7%	13.5%	11.7%	9.6%	7.4%	4.9%	3.1%	0.9%	-1.2%	-3.2%

### Scenario #2

Uncommitted Additions	9	1,167	5,792	9,660	10,852	11,344	12,136	13,316	13,360	13,404
Scheduled Maintenance	-1,332	-3,779	-3,713	-3,635	-3,155	-3,415	-3,155	-3,155	-3,155	-3,155
Forced Outages	-7,618	-7,889	-8,234	-8,474	-8,563	-8,532	-8,611	-8,644	-8,647	-8,649
Adjusted Generation Capacity	174,959	176,686	182,105	186,209	188,025	188,015	189,489	190,638	190,679	190,721
Demand Escalation (%)	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Escalated Demand + Losses	151,245	154,717	158,082	161,481	165,282	168,915	172,646	176,370	180,081	183,888
Resource Margin (MW)	23,714	21,969	24,023	24,728	22,743	19,100	16,843	14,268	10,598	6,833
Resource Margin (%)	15.7%	14.2%	15.2%	15.3%	13.8%	11.3%	9.8%	8.1%	5.9%	3.7%

### Scenario #3

Uncommitted Additions	0	0	0	0	0	0	0	0	0	0
Scheduled Maintenance	-1,332	-3,779	-3,713	-3,635	-3,155	-3,415	-3,155	-3,155	-3,155	-3,155
Forced Outages	-7,618	-7,828	-7,939	-7,969	-7,999	-7,945	-7,983	-7,983	-7,983	-7,983
Adjusted Generation Capacity	174,950	175,580	176,608	177,054	177,737	177,258	177,981	177,983	177,983	177,983
Demand Escalation (%)	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
Escalated Demand + Losses	158,344	161,875	165,527	169,083	173,064	176,786	180,574	184,547	188,466	192,459
Resource Margin (MW)	16,606	13,705	11,081	7,971	4,673	472	-2,593	-6,564	-10,483	-14,476
Resource Margin (%)	10.5%	8.5%	6.7%	4.7%	2.7%	0.3%	-1.4%	-3.6%	-5.6%	-7.5%

### Scenario #4

Uncommitted Additions	0	0	0	0	0	0	0	0	0	0
Scheduled Maintenance	-1,332	-3,779	-3,713	-3,635	-3,155	-3,415	-3,155	-3,155	-3,155	-3,155
Forced Outages	-7,618	-7,828	-7,939	-7,969	-7,999	-7,945	-7,983	-7,983	-7,983	-7,983
Adjusted Generation Capacity	174,950	175,580	176,608	177,054	177,737	177,258	177,981	177,983	177,983	177,983
Demand Escalation (%)	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Escalated Demand + Losses	162,656	166,268	169,868	173,570	177,661	181,487	185,376	189,455	193,479	197,579
Resource Margin (MW)	12,294	9,312	6,740	3,484	77	-4,229	-7,395	-11,472	-15,496	-19,596
Resource Margin (%)	7.6%	5.6%	4.0%	2.0%	0.0%	-2.3%	-4.0%	-6.1%	-8.0%	-9.9%

\*\*Resource Margin is the available resource capacity in excess of the escalated demand, after resources are adjusted for outages

## Summary of Adjustments (January)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<b>Base Capacity (January)</b>										
Total Unadjusted Committed Generation capacity	187,995	190,220	192,487	192,593	192,430	192,931	192,933	192,933	192,933	192,933
Adverse Hydro Derate	-5,163	-5,114	-5,085	-5,054	-5,005	-5,005	-5,005	-5,005	-4,995	-4,984
Total De-rated Generation	182,832	185,106	187,402	187,539	187,425	187,926	187,928	187,928	187,938	187,949
Total Unadjusted Demand	124,354	126,840	129,542	132,205	134,947	137,579	140,342	143,073	145,856	146,740
Estimated Planning Margin (%)	47.0%	45.9%	44.7%	41.9%	38.9%	36.6%	33.9%	31.4%	28.9%	28.1%

(all values in megawatts unless otherwise designated)

### Scenario #6

Uncommitted Additions	0	0	0	0	0	0	0	0	0	0
Scheduled Maintenance	-10,680	-10,928	-10,386	-9,616	-10,060	-9,921	-10,199	-10,149	-10,207	-10,149
Forced Outages	-6,953	-7,123	-7,312	-7,361	-7,331	-7,368	-7,349	-7,354	-7,350	-7,352
Adjusted Generation Capacity	165,199	167,055	169,704	170,562	170,033	170,636	170,379	170,425	170,380	170,447
Demand Escalation (%)	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Escalated Demand + Losses	133,595	136,238	139,105	141,959	144,893	147,709	150,679	153,652	156,710	157,633
Resource Margin (MW)	31,604	30,817	30,599	28,603	25,140	22,928	19,701	16,773	13,671	12,815
Resource Margin (%)	23.7%	22.6%	22.0%	20.1%	17.4%	15.5%	13.1%	10.9%	8.7%	8.1%

## G. Description of Model

The “Supply Adequacy Model” (SAM) was developed by the CEC to study the balance between projected demands and resources in California and other WECC areas, taking into consideration transmission limitations between sub-areas. The model has the capability to perform either multiple-iteration probabilistic (stochastic) studies or single-iteration deterministic studies. Per instructions from the Reliability Subcommittee, all of the studies conducted for this report were deterministic. If probabilistic studies are requested in the future, it will be necessary to collect additional information.

For the purposes of this model, the WECC region is divided into the following sub-areas or zones. The zones are configured around demand centers and transmission hubs. Refer to the topology bubble diagram for connections between zones.

Alberta	California, SMUD	Nevada, North
Arizona	California, South	Nevada, South
British Columbia	CFE-Mexico	New Mexico
California, Central	COB	Northwest
California, IID	Colorado, East	Palo Verde
California, LADWP	Colorado, West	Utah
California, North	Four Corners	Wyoming
California, San Diego	Idaho	
Calif., San Francisco	Montana	

The zones COB, Four Corners, and Palo Verde have no load assigned to them.

The following acronym definitions apply to this report.

AZ-NM-SNV	Arizona – New Mexico – Southern Nevada
CA-MX	California – Mexico (CFE –WECC)
CFE	Comision Federal de Electricidad
CAISO	California Independent System Operator
COB	California Oregon Border
IID	Imperial Irrigation District
LADWP	Los Angeles Department of Water and Power
MAPP	Mid-Continent Area Power Pool
NWPP	Northwest Power Pool
PSC	Public Service of Colorado
RMPA	Rocky Mountain (Colorado – Wyoming)
SMUD	Sacramento Municipal Utility District
SPP	Southwest Power Pool
WACM	WAPA – Colorado / Missouri
WALC	WAPA – Lower Colorado

### **Demands**

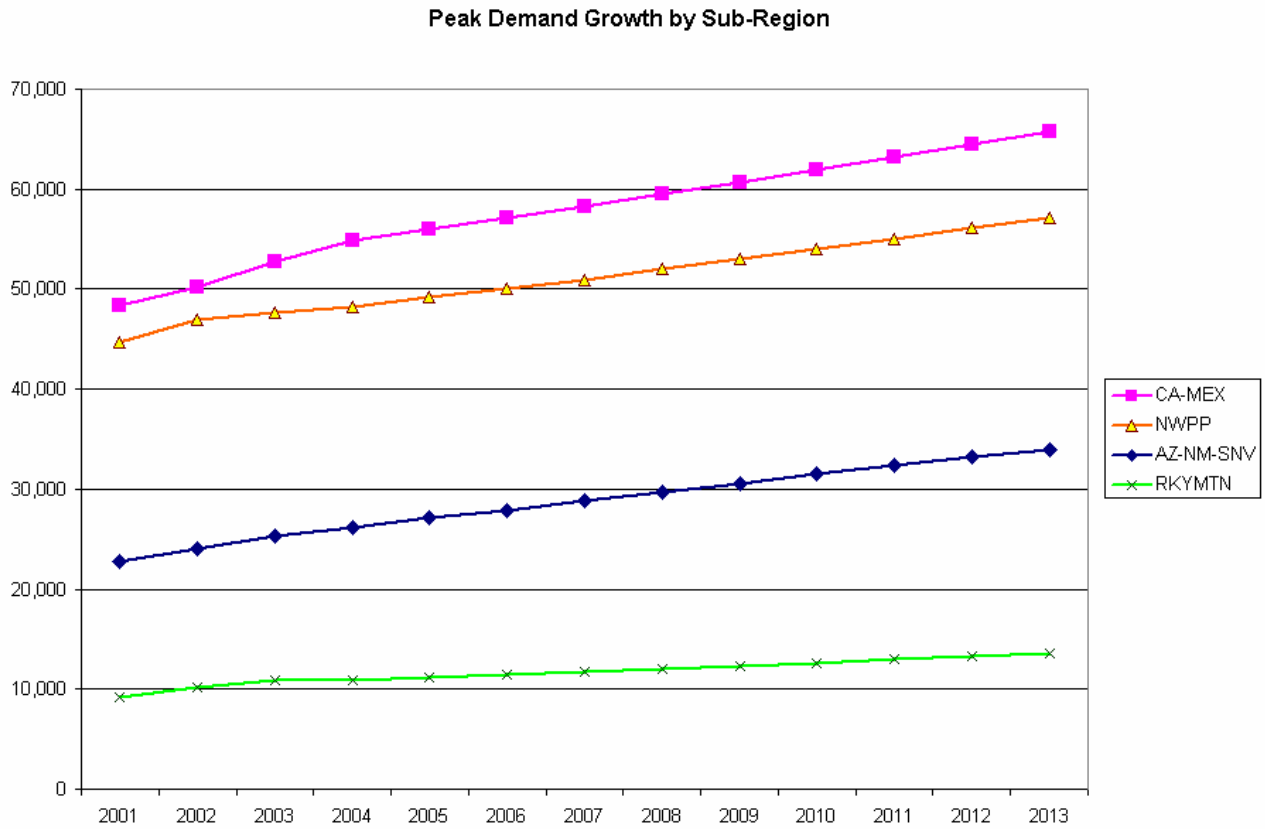
Estimated monthly peak demands for each SAM zone are included in the input data. These peak demands are derived from the peak demand forecasts that were submitted with the L&R data, and represent a 1-in-2 year probability forecast (50% probability of not being exceeded). The current methodology assumes that every zone will experience its monthly peak demand at the same time. This non-coincidental approach has a tendency to overstate the peak demands where geographical and temperature diversity decrease the likelihood of simultaneous peaks across an area or region. Demand diversity may be accounted for in future assessments, provided that the necessary data can be gathered.

Where control areas spanned more than one zone, the demands were allocated by percentages (see details in Assumptions). The following table (Table #5) is an area summary of the actual and forecast total (firm plus non-firm) August peak demands through 2008.

Table #3 - Total August Peak Demands by Sub-Region (MW)

Sub-Region	2002	2003	2004	2005	2006	2007	2008
AZ-NM-SNV	23,976	25,376	26,182	27,083	27,924	28,828	29,747
CA-MX	50,260	52,727	54,881	55,955	57,132	58,297	59,499
NWPP	47,008	47,666	48,224	49,193	50,072	50,928	52,053
RMPA	10,135	10,950	10,874	11,109	11,400	11,688	11,991
Total WECC	131,379	136,729	140,161	143,340	146,528	149,741	153,290

Graph #7 – Peak Demand Growth



**Resources**

The resource data includes the existing generation units, the generation additions, the generation retirements, the scheduled maintenance, the inoperable generation, the forced outages, and miscellaneous deratings. The net resource capacities were summarized by zone and type (hydro or non-hydro) before being copied into the model. The detailed generation data are available in the WECC publication (*Existing Generation and Significant Additions and Changes to System Facilities 2003 – 2013*).

The tables below are a summary of the generation additions/retirements that became available or unavailable from 2003 through 2013 (months are inclusive). Committed generation is generation that is currently in start-up or under construction. Uncommitted generation is generation that has not started construction. Although the plans could change, generation retirements were considered as committed, unless the associated (replacement) generation additions were uncommitted.

Table #4 - Generation Additions (committed and uncommitted) by Area (MW)

Area	1/03-8/03	9/03-8/04	9/04-8/05	9/05-8/06	9/06-8/07	9/07-8/08	9/08->
Canada	910	522	778	25	689	4	502
Northwest	283	987	997	3,901	1,684	525	575
Rockies	798	698	0	274	0	0	500
No. Calif.	2,801	27	877	500	1,200	0	0
So. Calif./Mex	2,683	695	1,831	1,666	855	0	1,522
Desert SW	4,588	3,177	890	1,173	1,135	916	538
Total	12,063	6,106	5,373	7,539	5,563	1,445	3,637

Table #5 - Generation Retirements (committed and uncommitted) by Area (MW)

Area	1/03-8/03	9/03-8/04	9/04-8/05	9/05-8/06	9/06-8/07	9/07-8/08	9/08->
Canada	0	0	0	0	0	0	0
Northwest	-27	-64	0	-280	0	0	0
Rockies	0	0	0	0	0	0	0
No. Calif.	-351	-967	-163	0	-679	0	0
So. Calif./Mex	-421	-1,775	-304	0	-600	0	-277
Desert SW	-96	-575	0	-1,580	-48	-48	-48
Total	-895	-3,381	-467	-1,860	-1,327	-48	-325

Table #6 - Net Generation Additions (committed and uncommitted) by Area (MW)

Area	1/03-8/03	9/03-8/04	9/04-8/05	9/05-8/06	9/06-8/07	9/07-8/08	9/08->
Canada	910	522	778	25	689	4	502
Northwest	256	923	997	3,621	1,684	525	575
Rockies	798	698	0	274	0	0	500
No. Calif.	2,450	-940	714	500	521	0	0
So. Calif./Mex	2,262	-1,080	1,527	1,666	255	0	1,245
Desert SW	4,492	2,602	890	-407	1,087	868	490
Total	11,168	2,725	4,906	5,679	4,236	1,397	3,312

The number of planned generation additions has dropped off significantly from the high pace seen in 2002 and 2003. At the same time, the number of planned retirements has increased. The following tables break out the generation additions that are uncommitted, or that have not started construction.

Table #7 - Uncommitted Generation Additions/Retirements by Area (MW)

Area	1/03-8/03	9/03-8/04	9/04-8/05	9/05-8/06	9/06-8/07	9/07-8/08	9/08->
Canada	0	0	250	0	684	0	500
Northwest	0	9	667	3,271	1,684	525	575
Rockies	0	0	0	274	0	0	0
No. Calif.	0	0	105	0	521	0	0
So. Calif./Mex	0	0	76	0	245	0	1,522
Desert SW	0	0	60	1,080	734	667	485
Total	0	9	1,158	4,625	3,868	1,192	3,082

Table #8 - Committed Net Generation Additions by Area (MW)

Area	1/03-8/03	9/03-8/04	9/04-8/05	9/05-8/06	9/06-8/07	9/07-8/08	9/08->
Canada	910	522	528	25	5	4	2
Northwest	256	914	330	350	0	0	0
Rockies	798	698	0	0	0	0	500
No. Calif.	2,450	-940	609	500	0	0	0
So. Calif./Mex	2,262	-1,080	1,451	1,666	10	0	-277
Desert SW	4,492	2,602	830	-1,487	353	201	5
Total	11,168	2,716	3,748	1,054	368	205	230

Scheduled maintenance and inoperable generation as reported in the L&R data were included as indicated in the studies. The majority of the August outages are scheduled for generation in Alberta and British Columbia. Other areas try to have all their units available for the summer peak.

### **Resource Adjustments - Hydro**

In addition to the individual hydro generation capacities (seasonal median output) submitted with the L&R data, aggregate hydro capacities to reflect adverse water conditions are provided by the WECC control areas. The differences in total capacity represent the hydro capacity de-rates for each control area. The following tables present the hydro de-rates by sub-region for January and August.

Table #9a – January Hydro De-rates by Sub-Region (MW)

Sub-Region	2005	2006	2007	2008	2009	2010	2011
AZ-NM-SNV	0	0	0	0		0	0
CA-MX	1,044	1,023	1,022	1,021	1,020	1,020	1,020
NWPP	3,977	3,976	3,957	3,927	3,879	3,879	3,879
RMPA	123	123	123	123	123	123	123
Total WECC	5,163	5,114	5,085	5,054	5,005	5,005	5,005

Table #9b – August Hydro De-rates by Sub-Region (MW)

Sub-Region	2004	2005	2006	2007	2008	2009	2010
AZ-NM-SNV	0	0	0	0	0	0	0
CA-MX	164	123	122	121	120	120	120
NWPP	3,801	3,812	3,794	3,764	3,737	3,737	3,737
RMPA	3	3	3	3	3	3	3
Total WECC	3,929	3,890	3,871	3,840	3,812	3,812	3,812

The hydro generation unit capabilities submitted by the CAISO were generally nameplate capabilities. These were reduced to nominal levels in accordance with data found in the CAISO seasonal assessments.

### **Resource Adjustments – Non-hydro**

The non-hydro generation capacities were de-rated in all of the scenarios to model forced outages. An 8% de-rate was applied to the zones associated with the CAISO and LADWP due to a high proportion of older thermal units and stringent environmental levels. In all of the other zones the seasonal non-hydro capacities were reduced by 5%. This 3% differential is supported by historical Loads and Resources data for actual year forced outage capabilities. As more of the older plants are retired in California, the forced outage rate will likely be decreased.

### **Wind De-rates**

The generation capacity of wind powered resources is unpredictable, especially for the monthly peak hour. WECC has not developed a standard de-rate and generally accepts the capacity values provided by each control area. The reported capabilities vary between a 30% de-rate and a 100% de-rate from the installed/nameplate capacities and no further de-rates were applied, except for the described forced outage rates. For WECC overall, the summer de-rate is approximately 86% and the winter de-rate is approximately 77%.

### **Transfer Paths**

The transfer paths used by the program are based on the SAM zones, with paths connecting one SAM zone to another SAM zone where applicable. The model has data fields for the path, transfer capability, wheeling cost, and loss factor. The wheeling costs for each path are used to calculate the transfer costs for any imports into a zone. The loss factors are used to calculate the net transfer after losses for any imports into a zone. Standardized wheeling costs were used in the studies.

A request was sent out to a key control area in each zone to provide information on the transfer capabilities between zones. The responses were used to update the capabilities in the model based on the values provided.

### **Solution**

Microsoft Solver, a third-party tool included with Excel for solving constraint-based problems, is used to solve the demand/resource balance and calculate the surplus generation in each zone. The solution seeks the lowest overall resource cost subject to the following constraints:

- the demand requirements of each zone must be met (surplus  $\geq 0$ ); but it's possible for a zone to be deficit before solver starts
- the resource solution for each zone must be equal to or greater than zero
- the resource solution for each zone must not be greater than the available resources

- the resource solution for each zone must not be less than the minimum resource allocation

The solution uses transfers between zones to export resources from surplus zones to deficit zones. If a deficit is greater than the available transfer capability from the connected zones, then the zone will have a net deficit. The solution will also back off internal generation in a zone if a connecting zone has a surplus that is less expensive and the transfer path has available capability. Lower cost resources such as hydro resources are given priority within a zone and as imports, to serve local load and to displace more expensive generation.

The assessment model is designed to measure the supply/demand margins based on forecasts of peak demands and resources. While peak demand forecasts for several years into the future are readily available from the WECC control areas, the forecasts of resource additions only exist for a few years into the future. Therefore, the validity of the results decreases the further out one looks. The assessment results for the period beyond 2005 or 2006 are not a realistic picture of future supply margins. The addition of generation plants that are not accounted for in the current data should be expected. There is a point where the results shift from a determination of supply margin to a determination of future needs.

## **H. Application Summary**

The SAM program uses an iterative methodology to determine the supply/demand margin. By design it isn't intended to perform a sophisticated engineering analysis. The solver add-in attempts to find a solution where resources and imports satisfy the demand requirements in each zone. The stochastic solutions model the system uncertainties based on historical demand and outage factors. The deterministic solutions simply compare total resources to total demands without modeling the uncertainties. For these studies, surplus is defined by the following formula.

$$\text{Surplus} = \text{Internal Resources} + \text{Imports} - \text{Demand} - \text{Exports}$$

While the model does consider transfer capabilities between zones, it is not designed to perform any sophisticated analysis of transfer limitations involving simultaneous flows or loop flows.

### **WECC Workarounds / Enhancements**

WECC has implemented workarounds and enhancements to address problems with using the WECC L&R data in SAM, and problems with external resources and the posting of summary results. An intermediate spreadsheet was developed that reads the L&R data from the standard WECC data files and aggregates the demands and resources by SAM zone.

A workaround to account for external resources was developed to force the transfer of some jointly owned generation (such as Palo Verde, Colstrip, and others) from the host zones to the appropriate participants' zones.

An enhancement to account for changes to transfer path capacities was also added.

### **Assumptions**

The following assumptions were used for the WECC studies:

- The input data represents demand forecasts and resource plans as of April 2004.
- Non-coincidental demands were used such that the monthly peak zonal demands are the sum of the control area peak demands for each zone.
- August data was used for the summer peak period for each year. January data was used for the winter peak period.
- This assessment assumes that the demand for a given zone is the sum of the control area customer demands within that zone. This differs from the "load requirement" concept where the load that must be served is the customer demand plus the firm exports. Under most circumstances, the application of "forced transfers" to accommodate firm exports would tend to undermine the model solution.
- Peak demands for CISO, PSC, WACM, and WALC were allocated to SAM zones based on the following ratios reported by the PCC representatives as part of their semi-annual review.

Table #8 - Percent of Control Area Demand Allocated to Zones

Zones \ Control Area	CISO	PSC	WACM	WALC
Arizona				72%
Colorado, East		88%	50%	
Colorado, West		12%	28%	
New Mexico				28%
Wyoming			22%	
California, North	39.4%			
California, Central	6.5%			
California, South	43.0%			
California, San Diego	8.6%			
California, San Fran.	2.5%			

- Since insufficient data were available for a detailed economic solution, the summary resources in each zone were all assigned the same costs (Hydro = \$5/MWH, Non-hydro = \$20/MWH), with the exception of Palo Verde (\$15/MWH).
- The adjustments for external generation that were used in the studies were for Bridger, Colstrip, Four Corners, Hayden, Hoover, Intermountain, Mohave, Navajo, Palo Verde, San Juan, and San Onofre. No other adjustments were made for other joint plants or firm purchases.
- Ties to MAPP and SPP are not modeled since this would require generation and/or demand to be associated with these external areas. Long term contracts that result in consistent imports or exports could be represented in the model if the Reliability Subcommittee determines that this is appropriate.
- The model freely transfers resources from areas with surplus generation to deficit areas, considering transfer path constraints and transmission losses. Simultaneous flows, loop flows, and other transfer restrictions are approximated by the adverse OTC limits that were used in the studies.
- The model is not intended to measure the supply margins in the individual control areas (unless the zone definition and transfer capabilities exactly match the control area). The model assumes that there are no constraints internal to a zone.

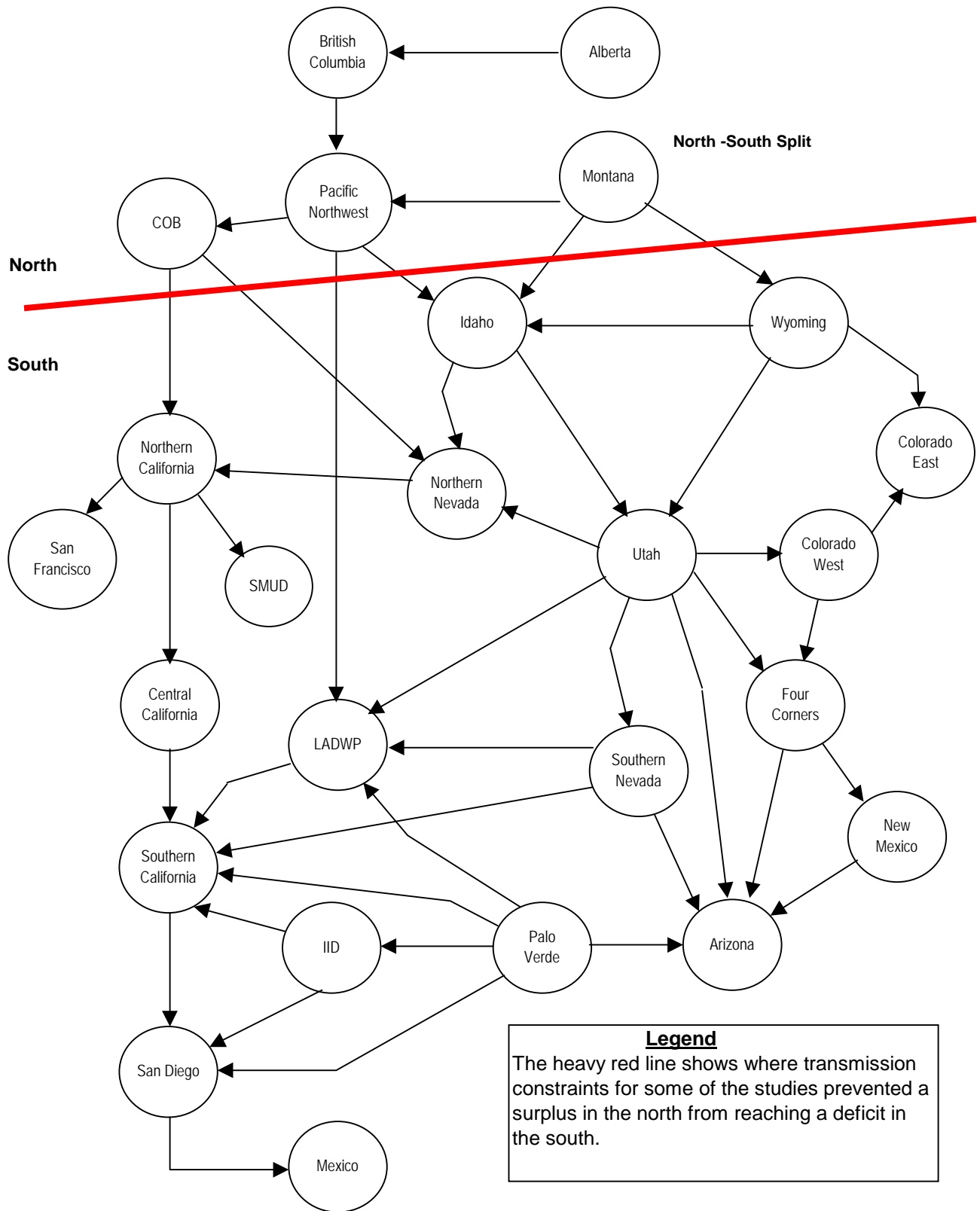
## **I. Observations**

1. Surplus generation in the Pacific Northwest was often stranded due to transmission limitations (see Bubble Diagram #3 on page 27 for constraint points). The accuracy of the stranded surplus is uncertain, in light of the complicated hydro restrictions that apply to the northwest. For example, in the spring and early summer hydro flows are increased to simulate to some degree natural spring runoff for fish migration. The goal of filling the reservoirs for summer recreation use and winter power generation is often unrealized.
2. There were cases where surplus resources were available, but transfer path limitations prevented the surplus from reaching the areas with deficits. Whenever an individual zone became deficit while the Interconnection overall had a surplus (sum of zonal surpluses/deficits were greater than zero), there were one or more transfer path limitations

between the surplus area(s) and the deficit area(s). The predominant locations of these constraints are shown in Bubble Diagram #3 on page 27.

3. The assessment results for the period beyond 2006 do not represent a realistic picture of future power supply margins, but do represent a picture of future resource needs for the given load forecast and transmission system. The addition of generation plants that are not accounted for in the current data should be expected. There is a point where the results shift from a determination of supply margin to a determination of future needs.
4. The model assumes an idealistic efficiency where resources and transmission become immediately available as necessary to meet demand requirements. Economical system operation and other conditions could adversely affect the availability of resources, and could impact the amount and timing of power supply deficiencies.
5. The most common approaches for resolving power supply deficiencies are the addition of generating capacity or the addition of transmission capability. Given the projected rate of load growth and the difficulties in financing and siting transmission lines, it may be more practical to add generation capacity in the areas that are anticipating supply deficits.

Bubble Diagram #3 – Constrained Paths (Summer)



## **WESTERN ELECTRICITY COORDINATING COUNCIL**

### **POWER SUPPLY ASSESSMENT POLICY**

#### INTRODUCTION

The Western Electricity Coordinating Council was established to promote the reliable operation of the interconnected bulk power system by the coordination of planning and operation of generating and interconnected transmission facilities.

The Planning Coordination Committee assigned the Reliability Subcommittee the task of developing an Adequacy of Supply Assessment Methodology. This document establishes the policy for conducting power supply assessments using the methodology developed by the Reliability Subcommittee. This policy shall be periodically reviewed and revised as experience indicates.

#### PURPOSE OF POWER SUPPLY ASSESSMENT

To ensure the reliability of the interconnected bulk electric system, it is necessary to assess both the security and the adequacy of the overall Western Interconnection. This document is focused on the portion of the assessment dealing with the adequacy of power supply. As electric industry restructuring has begun to break apart the traditional model of the vertically integrated utility, the responsibility for maintaining the adequacy of the power supply is moving toward market mechanisms. Though there may not be specific entities entrusted to plan for adequate resources, there exists a need to assess whether projected resources will be sufficient to reliably meet demand. Such information will allow regulators and policy makers to anticipate potential shortfalls so that determinations can be made as to whether impediments or insufficient incentives exist in the market.

It is not the intent of an adequacy assessment to replace the market, create sanctionable criteria or anticipate future energy prices. Its purpose is to project whether enough resources exist, at any price, to meet load and possible reserves while considering the transmission transfer capabilities of major paths. Such an assessment is required to comply with the NERC Planning Standards. These standards require that each region perform a regional assessment of existing and planned (forecast) adequacy of the bulk electric system.

It is recognized that it is impossible to provide 100% adequacy of power supply. It is the purpose of this document to establish a uniform policy for assessing the adequacy of installed and planned resources within the WECC region for the purposes of reporting within the Council, and to outside agencies. The assessments shall cover a period encompassing the next 5 years.

## ASSESSMENT METHODOLOGY

The Power Supply Assessment Methodology shall be developed and maintained by the Reliability Subcommittee. Adequacy of supply may be defined and measured in terms of generating reserve margins and transmission limitations between load and resource areas and/or based on probabilistic methods. Appropriate technical tools shall be developed and utilized in conducting the assessments. The assessments shall account for diversity of load and generation, and account for transmission constraints between load and resource areas.

## DATA REQUIREMENTS

To aid WECC in assessing resource adequacy, the following information shall be provided by the WECC member systems:

### Load Forecasts

- Electricity demand and energy forecasts, including uncertainties
  - Variations due to weather
  - Variations due to other factors affecting forecasts

### Demand Side Management (DSM) Programs

- Existing and planned demand-side management programs
  - Direct controlled interruptible loads
  - Aggregate effects of multiple DSM programs

### Resource Information

- Supply-side resource characteristics, including uncertainties
  - Consistent generator unit ratings, including seasonal variations and environmental considerations affecting hydro and thermal units
  - Availability of generating units
  - Fuel type

### Transmission Information

- Capabilities, availability of transmission capacity, and other uncertainties

REPORTING OF POWER SUPPLY ADEQUACY

The assessment of generating reserve margins and transmission limitations between load and resource areas as well as probabilities of supplying expected load levels, accounting for uncertainties, shall be developed and the results reported on a seasonal basis. The assessment shall be consistent with the requirement for maintaining operating reserves as defined in the *WECC Minimum Operating Reliability Criteria* and NERC Operating Policies.

Approved by Reliability Subcommittee June 16, 2000

Approved by Planning Coordination Committee June 30, 2000

Approved by Board of Trustees August 8, 2000

Revised April 18, 2002

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