Western Electricity Coordinating Council Regional Planning
Project Review
Loads and Resources Working Group

Demand Analysis of 2015 Scenarios
To Explore the Range of Need for a Canada/Pacific Northwest to Northern California Line

The purpose of this study is to explore the range of need for the Canada/Pacific Northwest to Northern California Line to assist subsequent efforts to identify project alternatives. This study does not assign any particular probability, likelihood or weighting of the scenarios considered, and it is not intended to be used to identify the preferred alternative for the transmission line or assess the feasibility of any transmission line alternative.

Introduction

This report describes a study by the Loads and Resources (L&R) Working Group to identify the range of need for new transmission capacity interconnecting Canada, the Pacific Northwest and California. The study consisted of a screening-level, summer peak demand analysis of scenarios for the year 2015. This study is the first of the three phases of the Western Electricity Coordinating Council (WECC) Regional Planning Project Review for the Canada/Pacific Northwest to California transmission line (www.pge.com/biz/transmission_services/canada/). This study and the report were produced using an open stakeholder process.

The Technical Analysis Subcommittee will use results of this study to identify the electrical alternatives and costs for the transmission line. Once the electrical alternatives and costs have been identified, the Economic Analysis Subcommittee will assess the economic benefits and costs of the various electrical alternatives for the transmission line.[1]

Methodology

The methodology used for this demand analysis involved estimating, for various scenarios, 1) the quantity of new resources each area in the Western Interconnection will need in 2015 to meet summer peak demand plus a 15% reserve margin, and 2) the types and quantities of new renewable resources that may be available in each area. Because PG&E is primarily interested in new renewable resource potential in Canada and the Pacific Northwest, the scenarios portray incremental renewable resource potential and are not designed to examine all (e.g. renewable vs. non-renewable) resource potential. These estimates were then used to identify potential needs for new transmission (e.g., the Canada/Pacific Northwest to California line) between the areas where resources will be available and the areas where resources will be needed.

The California Energy Commission's (CEC) proprietary Supply Adequacy Model (SAM) was used to identify each area's need for capacity supply in summer 2015 and each area's potential for providing capacity supply to the capacity deficient areas. The Supply Adequacy Model was developed by the CEC to study the balance between projected demands and resources in California and other areas of the Western Interconnection, taking into consideration transmission limitations between the areas. The Western Electricity Coordinating Council (WECC) has been using SAM for its annual Power Supply Assessment (PSA) study, and SAM input data to model the WECC system in the year 2015 were readily available from WECC.

For this study, the Loads and Resources Working Group started with input data derived from the WECC 2006 PSA study and made certain updates and adjustments, such as to represent the dependable capacity of resources rather than the nameplate capacity.

[1] More specific details on the work of the Technical Analysis and Economic Analysis Subcommittees, including the methodologies they will use and the information they will develop, will be described in separate documents.

Before providing us the 2015 data, WECC staff aggregated data for some of the areas used in the PSA to avoid disclosing potentially market sensitive data for any individual members. Even with this aggregation, there were enough areas to conduct a meaningful assessment. (See Figure 1, attached.)

A demand assessment of the type conducted for this study can identify whether a transmission line would be potentially required for meeting an area's need for new capacity during the annual peak load hour, but it does not consider the other important benefits that may justify new transmission capacity, including:

- Access to sources of renewable energy for satisfying Renewable Portfolio Standard (RPS) requirements
- Reduced cost of energy, not only during average conditions, but also during both favorable and adverse conditions (e.g., wet and dry hydro conditions, and hotter or cooler than normal temperatures)
- Lower cost to integrate intermittent renewable resources, such as by delivering the peak output of wind generation to areas with sufficient demand and regulation capability to handle the power swings
- Improved electric system performance (e.g., improved stability, lower losses); and
- Regional benefits (California's load peaks in the summer, the Pacific Northwest and Canadian loads peak in the winter).

The full range of potential benefits will be considered and quantified in subsequent phases of the transmission study effort (i.e., by the Technical and Economic Analysis Subcommittees).

Because a Canada/Pacific Northwest to California transmission line would undoubtedly have more benefits than this demand assessment identifies, it is possible that the subsequent phases may find that it would be beneficial to have a larger capacity line than this study indicates.

Scenarios

The Loads and Resources Working Group developed three scenarios to assess need for new transmission capacity:

- Scenario 1: WECC PSA Adjusted
- Scenario 2: Canada Renewable
- Scenario 3: Northwest U.S. Renewables

All three scenarios were designed to meet a 15% minimum planning reserve margin for the WECC assuming different levels of imports into California. Scenarios 2 and 3 represent the range of renewable resource potential in the Pacific Northwest and Canada.

None of the three scenarios are intended to represent the most efficient or cost effective alternative or the "base case" for resources and/or transmission. This study does not

assign any particular probability, likelihood or weighting of the scenarios, and finding the preferred alternative for the Canada/Pacific Northwest to California transmission line or assessing alternative feasibility are not the purposes of this study. Furthermore, assessing the resource adequacy of any area or entity is not a purpose of this study. Rather, the purpose of studying these scenarios is to gain insight into the range of need for new transmission for a variety of resource alternatives that meet WECC load requirements and Renewable Portfolio Standard requirements.

From the identified range of transmission need, the Technical Analysis Subcommittee will develop a variety of electrical alternatives and develop rough estimates of each alternative's cost. Then, the Economic Analysis Subcommittee will assess the economic benefits of the various electrical alternatives considering a variety of future scenarios.[2]

Load and Resource Modeling

The study year selected was 2015, which corresponds to the latest year of data for production simulation studies that is available from WECC. Loads were adopted from the WECC 2006 Power Supply Assessment (May 9, 2006) with a WECC peak demand of 183,322 MW (1 in 2 probability), and they reflect a long-term growth rate of about 2%. (See Table 1.)

[2] The Economic Analysis Subcommittee will review and, as appropriate, revise, discard or supplement the scenarios that were used in this study.

Table 1. Area Loads and Dependable Generation Capacities for 2015 from the WECC 2006 Power Supply Assessment, MW

Region	Generation	Load
Alberta	11,248	11,133
Arizona*	15,633	23,393
BCHA	13,001	9,434
CFE	2,358	2,173
Colorado	10,885	13,325
4 Corners	3,831	0
Idaho	2,472	4,799
IID	1,741	1,130
IPP	1,800	0
LADWP	5,658	6,808
Montana	3,007	2,084
N Nev	1,748	2,339
New Mex*	2,211	4,776
Northwest	37,912	25,027
PGE	29,268	30,398
PV	7,742	0
SCE	17,862	24,530
SDGE	2,999	5,338
S Nev	7,591	7,682
Utah	5,009	6,708
Wyoming	5,290	2,243
Total	189,266	183,322
* 800 MW of load was shifted from New Mexico to Arizona to more accurately reflect current forecasts.		

The starting point for the supply side also was the WECC 2006 Power Supply Assessment data for existing resources and planned additions through 2015, which totaled 200,761 MW nameplate capacity for the WECC region. The total nameplate capacity was derated by 11,495 MW, resulting in a total dependable capacity of 189,266 MW which more accurately represents the capability of the generation during summer peak conditions.

Scenario 1 – WECC PSA Adjusted

For this scenario, the PSA data were updated to reflect policies in California for development of energy efficiency programs (4% at peak load), demand response programs (5% at peak load) and meeting a renewable portfolio standard target of 20% with development of renewables native to California. It also reflects the expected retirement of aging power plants in California.

Key Adjustments from the 2015 WECC PSA data include:

- California Energy Efficiency Targets: 2,683 MW load reduction
- California Demand Response: 3,473 MW added

- Retirements: -10,000 MW California aging power plants, along the lines discussed in the CEC staff white paper, Resource, Reliability and Environmental Concerns of Aging Power Plant Operations and Retirements, August 13, 2004 (http://www.energy.ca.gov/2004_policy_update/documents/2004-08-26_workshop/2004-08-04_100-04-005D.PDF)
- Renewables: 15,757 MW of renewable generation was added to meet regional RPS targets.

				Solar	Biomass	Geothermal	Wind	Total
Region	Existing Renewables	RPS Target	Installed MW	aMW	aMW	aMW	aMW	aMW
CA	12%	20%	8,011	352	352	1,057	1,762	3,524
NW	2%	5%	3,325	146	146	439	731	1,463
RM	3%	10%	1,403	62	62	185	309	617
SW	3%	10%	3,018	133	133	398	664	1,328
WECC	6%	12%	15,757	693	693	2,080	3,466	6,932
% Energy Mix				10%	10%	30%	50%	100%

- Build-out: Adjusted natural gas and coal build-out to meet 15% minimum reserve requirement assuming 12,000 MW imports into California. First, 6,471 MW of new natural gas fired generation was added to California to meet 15% reserve margin after the retirements. Then 1,332 MW of new gas-fired generation was reduced in the surplus Northwest region and 3,113 MW of new coal generation was reduced in the Northwest, Rocky Mountain and Arizona regions on a pro-rata basis (63% of build out in the WECC (formerly SSG-WI) 2015 production simulation base case) to achieve 15% minimum reserve requirement. The assumed amounts of Canadian new gas-fired and new coal generation were not adjusted due to transmission constraints.
- The transfer path capabilities used in the WECC 2006 PSA were updated, as shown in Tables A-1 and A-2, attached. To enhance simulation accuracy, the PSA used dependable path capabilities, as provided by the path owners, rather than the maximum path capabilities for favorable conditions that are listed in WECC's Path Rating Catalog.
- The transfer path capabilities used in the WECC 2006 PSA include two lines between Four Corners and Arizona that were added to integrate new resources but are not yet under construction. The Navajo Transmission Project (approx. 1500 MW) is in Phase 1 of the WECC path rating process, and the Four Corners – Pinnacle Peak (approx. 1200 MW) is not yet in the WECC path rating process.
- Sierra Pacific's Ely Energy Center coal project, which is in the permitting phase, and the associated new 2,000 MW transmission line between northern Nevada and southern Nevada, were included in this scenario. To adjust for these additions, Northern Nevada coal generation was increased by 2,000 MW, Southern Nevada gas generation was reduced by 1,000 MW and Arizona gas generation was reduced by 1,000 MW.
- Detailed generation modifications to the WECC 2006 PSA data are shown in Table 2a, and the resulting total dependable generation capacity in each area are shown in Table 2b.

Table 2a. Scenario 1 – WECC PSA Adjusted: Generation level adjustments from the WECC 2006 PSA data for 2015, MW

Zone	Bio	Coal	DSM	Gas	Geo	Hydro	Oil	Solar	Wind	Retire
Alberta	0	973	0	805	0	-317	0	0	418	0
Arizona	0	2,140	0	1,700	0	0	0	0	375	0
BCHA	0	0	0	1,173	0	1,754	0	0	224	0
CFE	0	0	0	1,619	77	0	-300	0	0	0
Colorado	0	1,983	0	1,282	0	0	0	4	209	0
4 Corners	0	0	0	0	0	0	0	0	0	0
Idaho	0	371	152	34	0	0	0	0	148	0
IID	68	0	0	50	383	0	0	0	0	0
IPP	0	0	0	0	0	0	0	0	0	0
LADWP	0	0	190	957	0	0	0	102	258	-1,484
Montana	0	471	0	0	0	0	0	0	100	0
N Nev	0	2,261	0	191	397	0	0	0	150	0
New Mex	58	0	0	1,257	0	0	-20	0	0	0
Northwest	0	0	528	562	0	260	0	0	435	0
PGE	171	0	1,363	5,615	369	0	0	154	225	-4,204
PV	0	0	0	0	0	0	0	0	0	0
SCE	0	0	0	0	0	0	0	0	0	0
SDGE	261	-1,580	1,728	4,134	0	0	0	275	875	-3,991
S Nev	0	0	192	326	0	40	0	165	41	-321
Utah	0	252	0	446	0	0	0	28	0	0
Wyoming	0	362	0	-128	0	44	0	0	0	0
Total	**557**	**7,296**	**4,153**	**20,022**	**1,226**	**1,781**	**-320**	**728**	**3,632**	**-10,000**

Table 2b. Scenario 1 – WECC PSA Adjusted: Dependable generation capacities assumed for 2015, MW

Region	Bio	Solar	DSM	Geo	Wind	Hydro	Coal	Other	Retirements
Alberta	0	0	0	0	418	555	7,040	5,114	0
Arizona	0	10	0	0	379	1,691	7,476	10,293	0
BCHA	0	0	0	0	224	13,386	0	2,542	0
CFE	0	0	0	762	0	0	0	2,992	0
Colorado	0	4	0	0	228	1,045	6,917	6,168	0
4Corners	0	0	0	0	0	32	3,687	112	0
Idaho	0	0	152	0	150	2,179	371	325	0
IID	68	0	0	832	0	49	0	1,293	0
IPP	0	0	0	0	0	0	1,800	0	0
LADWP	0	102	190	0	258	1,436	0	5,178	-1,484
Montana	0	0	0	0	100	646	2,716	116	0
N Nev	0	0	0	524	150	3	2,783	1,286	0
New Mex	58	0	0	0	435	46	245	2,722	0
Northwest	0	0	528	0	622	28,622	1,957	7,968	0
PGE	171	154	1,363	1,796	234	9,404	191	23,852	-4,204
PV	0	0	0	0	0	0	0	7,742	0
SCE	261	734	1728	95	1535	1,475	-1,321	19,048	-3,991
SDGE	0	165	192	0	43	51	0	3,312	-321
S Nev	0	28	0	29	0	1,731	2,427	4,102	0
Utah	0	0	0	23	144	156	3,876	1,087	0
Wyoming	0	0	0	0	87	735	4,585	121	0
Grand Total of All Generation									218,341

The SAM results for Scenario 1 show no resource deficits in any region. (See Figure 1, attached.)

Scenario 1 is the starting point for both Scenario 2 and Scenario 3. The following descriptions illustrate how Scenarios 2 and 3 differ from the WECC PSA Adjusted Scenario. Tables A-3 and A-4, attached, summarize the area loads and generation, respectively for the three scenarios considered in this study.

Scenario 2 – Canada Renewables

Scenario 2 assumes the development of approximately 10,000 MW (nameplate) of renewable generation in British Columbia and Alberta (See Figure 2, attached). Various levels of reduction of gas-fired generation are assumed in Northern California to test differing levels of new transmission path ratings. Note that the methodology used in this study is indifferent as to the technology of the new generation. The nature of the generation resources that may develop and the impact of the technology type on the estimated benefits of the Canada/Pacific Northwest to California transmission line will be considered in later phases of the Feasibility Study.

The assumed dependable capacities[3] of the new renewable resources as percentages of the installed MW are:

- hydro 95%
- biomass and geothermal 90%
- wind 25%.

For example, 1,000 MW nameplate of wind generation would have a dependable capacity of 250 MW for the purposes of this study. (Conversely, for wind generation to achieve 250 MW of dependable capacity, 1,000 MW nameplate would have to be installed.)

Key Assumptions:

- Load and supply from Scenario 1 – WECC PSA Adjusted
- Add 7,000 MW renewable generation in British Columbia
- Add 3,000 MW renewable generation in Alberta
- Decrease gas-fired resources in PG&E's service area:
  - Case 1: 1,500 MW reduction
  - Case 2: 3,000 MW reduction
  - Case 3: 4,500 MW reduction
- Table 3 below shows the build-out assumptions (MW dependable capacity) of the additional new renewable resources

Table 3. Scenario 2 – Canada Resources: Generation level adjustments from Scenario 1, dependable MW

Area	Gas	Biomass	Geo	Wind	Hydro
Alberta	0	0	0	750	0
BCHA	0	1,350	0	1,275	360
PGE					
Case 1	-1,500	0	0	0	0
Case 2	-3,000	0	0	0	0
Case 3	-4,500	0	0	0	0
Total	-1,500 to -4,500	1,350	0	2,025	360

The hydroelectric generation used in this scenario is assumed to come from a large hydro facility. There is significant small hydro potential in British Columbia, but this potential was not included here due to a lack of information as to the specific location of resource pockets.[4] In addition, there is significant existing hydro capacity in British Columbia which might provide firming and shaping services for intermittent renewable generation.

[3] The Economic Analysis Subcommittee will review these assumptions during a later phase of the Canada/Pacific Northwest to California transmission line Feasibility Study.

[4] The BC Hydro 2005 Resource Options Report indentified 1,600 MW of small hydro potential (400 MW dependable capacity). The Technical and Economic Analysis subcommittees may want to examine small hydro development in their phases of this study.

SAM results for Scenario 2 show an approximate 1,200 MW deficit[5] in Southern California in Case 1, a 2,700 MW deficit in Case 2 and a 970 MW deficit in Northern California and 3,230 deficit in Southern California in Case 3[6]. (See Figures 3a and 3b, attached.) Transmission alternatives that could reliably deliver at least those levels of dependable capacity to Northern California would eliminate the estimated deficits in this scenario.

Scenario 3 – Northwest U.S. Renewables

Scenario 3 assumes the development of 5,250 MW (nameplate) of renewable generation in Eastern Washington, Eastern Oregon and Northwest Nevada[7]. (See Figure 2, attached) Various levels of reduction of gas-fired generation are assumed in Northern California to test differing levels of new transmission path ratings. The assumed dependable capacities[8] of additional renewable resources as percentages of the installed MW are the same as used in Scenario 2.

Key Assumptions:

- Load and supply from Scenario 1 – WECC PSA Adjusted
- Add 5,250 MW renewable generation in the Northwest U.S.
- Decrease gas-fired resources in PG&E's service area:
  Case 1: 1,500 MW reduction
  Case 2: 3,000 MW reduction
- Table 4 below shows build-out assumptions (MW dependable capacity) of additional new renewable resources.

Table 4. Scenario 3 – Northwest U.S. Renewables: Generation level adjustments from Scenario 1, dependable MW

Area	Gas	Biomass	Geo	Wind	Hydro
Northwest	0	45	180	1,250	0
PGE					
Case 1	-1,500	0	0	0	0
Case 2	-3,000	0	0	0	0
Total	-1,500 to -3,000	45	180	1,250	0

SAM results for Scenario 3 show an approximate 1,200 MW deficit in Southern California in Case 1 and a 2,700 MW deficit in Case 2. (See Figure 4, attached.) Transmission alternatives that could reliably deliver at least those levels of dependable

[5] The resource deficits indicated in this report do not reflect the resource adequacy of any area or entity.
[6] The assumed resource reductions in Northern California reduce export capability to Southern California, triggering deficits there in the SAM modeling.
[7] The section of Northwest Nevada examined here is assumed to be electrically connected to the Northwest area for the purposes of the SAM modeling.
[8] The Economics Subcommittee will review these assumptions during a later phase of the Canada/Pacific Northwest to California transmission line feasibility study.

capacity to Northern California would eliminate the estimated deficits. In this scenario, the incremental renewable generation additions are not sufficient on their own to make up for the shortfall in Case 2. Existing Northwest surplus generation or incremental Canadian generation are assumed to fill the remaining need.

Summary of Scenarios

Table A-5 (attached) shows the margin in each area that SAM computed for each scenario. Table A-6 (attached) shows the amount of resource deficit or excess in each area that SAM computed for each scenario as well as each of the transportation options discussed below.

Transportation Options

To resolve the resource capacity deficiencies identified in Scenarios 2 and 3, transportation options were developed and tested with the SAM program. The options are described below in tables that list the "Pre-Existing" capability of the identified path, as it is modeled in Scenario 1 (i.e., before addition of the transportation option), and the "After" capability, which is the total capability that this same path would have to be increased to in order to eliminate the area load deficiencies. Any one of the numbered transportation options below (e.g. Option 2-1) entirely eliminates the area supply deficiencies in the applicable scenario (e.g., Scenario 2). (Note that the first digit of each option number is the same as the applicable scenario number.)

As discussed above, the Technical Analysis Subcommittee will develop these transportation options into electric transmission alternatives.

Transportation Options for Scenario 2 – Canada Resources

The following table lists the transportation options that were found to eliminate the area supply deficiencies in Scenario 2.

Table 5. Transportation Options for Scenario 2 – Canada Resources

Option	Path	Total Path Capability, MW	
		Existing	After
2-1	Northwest-PGE [9]	4,200	5,700
2-2	Northwest-PGE	4,200	7,200
2-3	Northwest-PGE	4,200	8,700
2-4	BCH-PGE	0	3,000

[9] Note: Canadian System to Northwest US System transmission upgrades are not needed for reliability screening purposes during summer peak conditions (due to expected summer resource surplus conditions in the Northwest), but are expected to be needed for new deliveries of renewable energy from Canada.

Transportation Options for Scenario 3 – Northwest U.S. Renewables

The following table lists the transportation options that were found to eliminate the area supply deficiencies in Scenario 3.

Table 6. Transportation Options for Scenario 3 – Northwest U.S. Renewables

Option	Path	Total Path Capability, MW	
		Existing	After
3-1	Northwest-PGE	4,200	5,700
3-2	Northwest-PGE	4,200	7,200

Limitations

This study uses a transportation methodology to evaluate reliability in areas throughout the WECC, and to determine the effects of alternative transmission options on area reliability. This is a valid screening method that has been successfully used in other transmission study efforts. In one important manner, the Canada/Pacific Northwest to California transmission line proposal is different from other recent transmission proposals in that its primary purpose is to enable the flow of renewable energy among Canada, the U.S. Pacific Northwest and Northern California. Improvements in area reliability will certainly be a benefit from such a transmission line, but the primary purpose, renewable energy, is not a benefit the transportation methodology used here can evaluate. The costs and benefits of renewable energy, improved area reliability, and other considerations will be examined in the work done by the Economic Analysis Subcommittee.

As noted above in the footnote to Table 5, transmission improvements are not required between British Columbia and the U.S. Pacific Northwest for summer reliability purposes, but are likely necessary to ensure the flow of renewable energy year-round. For this reason, the Recommendations section below will include transmission options for the British Columbia – Pacific Northwest path.

Recommendations

The Loads and Resources Subcommittee recommends that the Technical Analysis Subcommittee develop electrical alternatives to accommodate the range of the transportation options described above and summarized in the following table. Those electrical alternatives should give the Economic Analysis Subcommittee an ample number and variety of alternatives for its evaluation in the final portion of Phase 1 of the Canada/Pacific Northwest to California transmission line feasibility study. In addition, if the Economic Analysis Subcommittee identifies other beneficial transportation options, it may request the Transmission Subcommittee to develop additional transmission alternatives.

Table 7. Recommended Incremental Transportation Options for Study by the Technical Analysis and Economic Analysis Subcommittees

Path	Total Path Capability, MW	
	Existing	Identified Incremental Options
Northwest-PGE	4,200	1,500
Northwest-PGE	4,200	3,000
Northwest-PGE	4,200	4,500
BCH-Northwest [10]	3,150	1,500
BCH-Northwest	3,150	3,000
BCH-Northwest	3,150	4,500
BCH-PGE	0	3,000

[10] Note: Canadian System to Northwest US System transmission upgrades are not needed for reliability screening purposes during summer peak conditions (due to expected summer resource surplus conditions in the Northwest), but are expected to be needed for new deliveries of renewable energy from Canada.

Table A-1. Path Capabilities for the Three Scenarios, MW

From	To	Capability
4Corners	Arizona	4,535
4Corners	Colorado	600
4Corners	New Mex	1,465
4Corners	Utah	600
Alberta	BCHA	0
Arizona	4Corners	4,350
Arizona	New Mex	1,125
Arizona	PV	6,970
Arizona	S Nev	4,727
Arizona	Utah	250
BCHA	Alberta	800
BCHA	Northwest	3,150
CFE	SDGE	1,200
Colorado	4Corners	550
Colorado	New Mex	200
Colorado	Utah	650
Colorado	Wyoming	1,400
Idaho	Montana	200
Idaho	N Nev	350
Idaho	Northwest	1,800
Idaho	Utah	680
Idaho	Wyoming	0
IID	PV	313
IID	SCE	600
IID	SDGE	1,150
IPP	LADWP	1,920
IPP	N Nev	190
IPP	Utah	1,100
LADWP	IPP	1,400
LADWP	Northwest	2,858
LADWP	PV	468
LADWP	S Nev	3,883
LADWP	SCE	3,750
Montana	Idaho	325
Montana	Northwest	2,000
Montana	Wyoming	400
N Nev	Idaho	185
N Nev	IPP	200
N Nev	Northwest	300
N Nev	PGE	100
N Nev	Utah	35

From	To	Capability
New Mex	4Corners	891
New Mex	Arizona	1,125
New Mex	Colorado	200
Northwest	BCHA	2,000
Northwest	Idaho	500
Northwest	LADWP	2,600
Northwest	Montana	1,000
Northwest	PGE	4,200
PGE	N Nev	100
PGE	Northwest	3,675
PGE	SCE	4,000
PV	Arizona	6,970
PV	IID	140
PV	LADWP	362
PV	SCE	2,037
PV	SDGE	970
S Nev	Arizona	4,785
S Nev	LADWP	2,300
S Nev	SCE	1,700
S Nev	Utah	250
SCE	IID	600
SCE	LADWP	3,750
SCE	PGE	3,000
SCE	PV	1,082
SCE	S Nev	2,814
SCE	SDGE	1,273
SDGE	CFE	408
SDGE	IID	150
SDGE	PV	1,168
SDGE	SCE	1,273
Utah	4Corners	530
Utah	Arizona	250
Utah	Colorado	650
Utah	Idaho	775
Utah	IPP	900
Utah	N Nev	170
Utah	S Nev	140
Utah	Wyoming	400
Wyoming	Colorado	1,400
Wyoming	Idaho	2,200
Wyoming	Montana	200
Wyoming	Utah	400

Table A-2. Path Capabilities Modifications from WECC 06 PSA Study to Canada/Pacific Northwest to California Transmission Study

Path Capability Modifications, MW

From	To	WECC 06 PSA	Canada Study
PGE	SCE	3,500	4,000
SCE	PGE	2,400	3,000
CFE	SDGE	0	1,200
IID	SDGE	150	1,150
IID	PV	163	313
PV	SCE	837	2,037
Colorado	New Mex	0	200
New Mex	Colorado	0	200
N Nev	S Nev	0	2,000
S Nev	N Nev	0	1,500
BCHA	Northwest	2,000	3,150
Northwest	BCHA	1,000	2,000

Table A-3. Area Loads for the Three Scenarios, MW

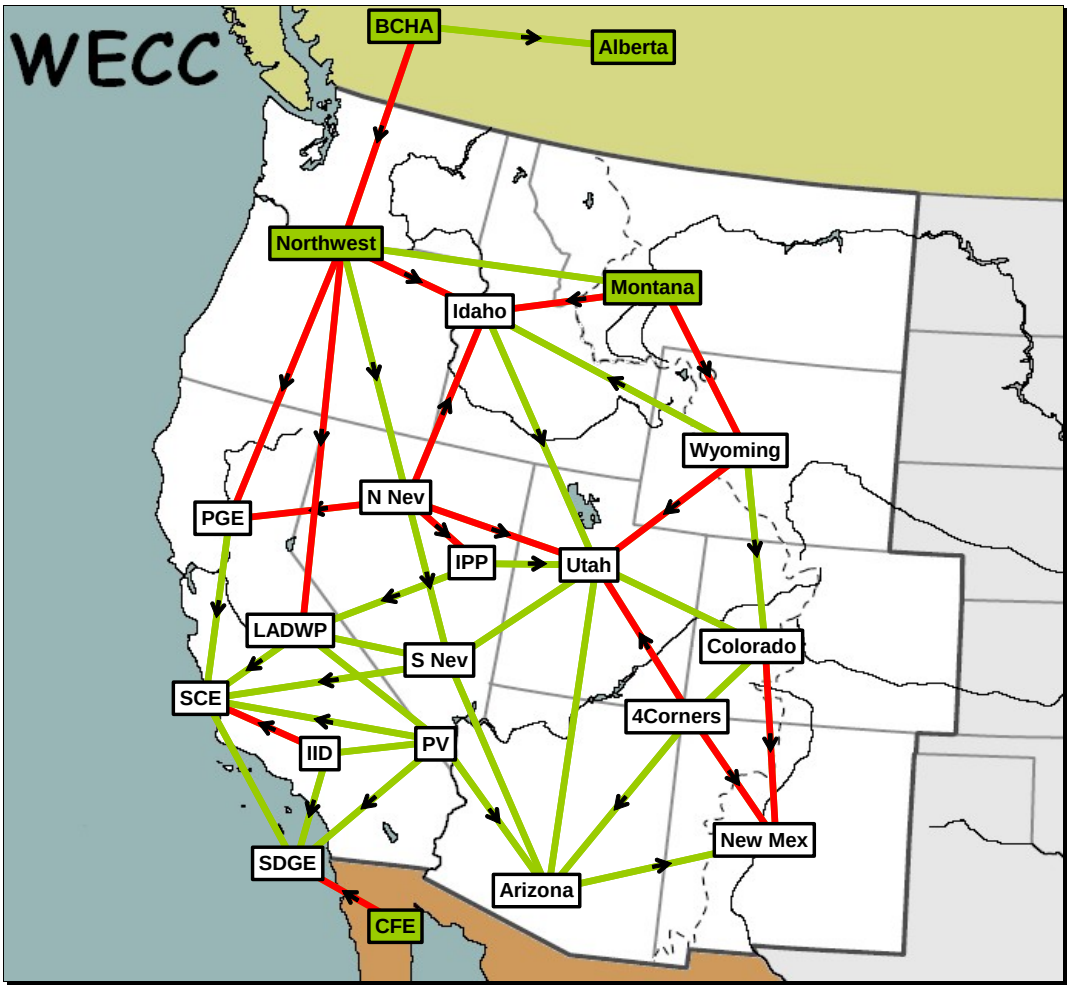
Region	WECC PSA 2006 Loads	Energy Efficiency	Adjusted Loads Scenarios 1, 2 and 3
Alberta	11,133	0	11,133
Arizona	23,393	0	23,393
BCHA	9,434	0	9,434
CFE	2,173	0	2,173
Colorado	13,325	0	13,325
4Corners	0	0	0
Idaho	4,799	0	4,799
IID	1,130	0	1,130
IPP	0	0	0
LADWP	6,808	-272	6,536
Montana	2,084	0	2,084
N Nev	2,339	0	2,339
New Mex	4,776	0	4,776
Northwest	25,027	0	25,027
PGE	30,398	-1,216	29,182
PV	0	0	0
SCE	24,530	-981	23,549
SDGE	5,338	-214	5,124
S Nev	7,682	0	7,682
Utah	6,708	0	6,708

Wyoming	2,243	0	2,243
Total	183,322	-2,683	180,639

Table A-4. Area Generation for the Three Scenarios, Dependable MW

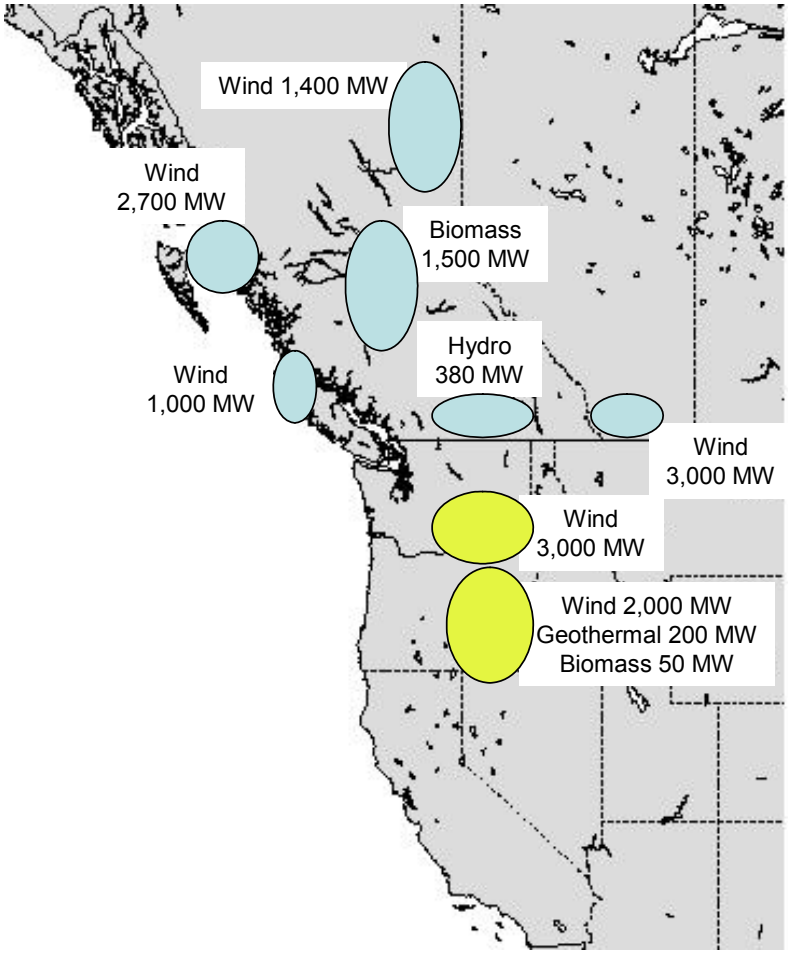
	Scenario-1	Scenario-2: Canadian Resources				Scenario-3: Northwest Resources		
Region	With Build-Out	Net Additions	Case-1	Case-2	Case-3	Net Additions	Case-4	Case-5
Alberta	13,126	750	13,876	13,876	13,876	0	13,126	13,126
Arizona	19,849	0	19,849	19,849	19,849	0	19,849	19,849
BCHA	16,152	2,986	19,138	19,138	19,138	0	16,152	16,152
CFE	3,755	0	3,755	3,755	3,755	0	3,755	3,755
Colorado	14,363	0	14,363	14,363	14,363	0	14,363	14,363
4Corners	3,831	0	3,831	3,831	3,831	0	3,831	3,831
Idaho	3,177	0	3,177	3,177	3,177	0	3,177	3,177
IID	2,241	0	2,241	2,241	2,241	0	2,241	2,241
IPP	1,800	0	1,800	1,800	1,800	0	1,800	1,800
LADWP	5,679	0	5,679	5,679	5,679	0	5,679	5,679
Montana	3,578	0	3,578	3,578	3,578	0	3,578	3,578
N Nev	4,747	0	4,747	4,747	4,747	0	4,747	4,747
New Mex	3,506	0	3,506	3,506	3,506	0	3,506	3,506
Northwest	39,697	0	39,697	39,697	39,697	1,475	41,172	41,172
PGE	32,961	0	32,961	32,961	32,961	0	32,961	32,961
PGE (Reduction)	0	0	-1,500	-3,000	-4,500	0	-1,500	-3,000
PV	7,742	0	7,742	7,742	7,742	0	7,742	7,742
SCE	19,564	0	19,564	19,564	19,564	0	19,564	19,564
3SDGE	3,441	0	3,441	3,441	3,441	0	3,441	3,441
S Nev	8,316	0	8,316	8,316	8,316	0	8,316	8,316
Utah	5,287	0	5,287	5,287	5,287	0	5,287	5,287
Wyoming	5,528	0	5,528	5,528	5,528	0	5,528	5,528
Total	218,341	3,736	220,577	219,077	217,577	1,475	218,316	216,816

Figure 1: Results for Scenario 1 - WECC PSA Adjusted



Key: Red zone – less than 15% reserve margin
Green zone – more than 15% reserve margin
White zone – exactly 15% reserve margin
Red line – path fully loaded in the direction of the arrow
Green line – path partially loaded in the direction of the arrow
Green line with no arrow – path with no flow

Figure 2: Scenario Map – Year 2015 Assessment

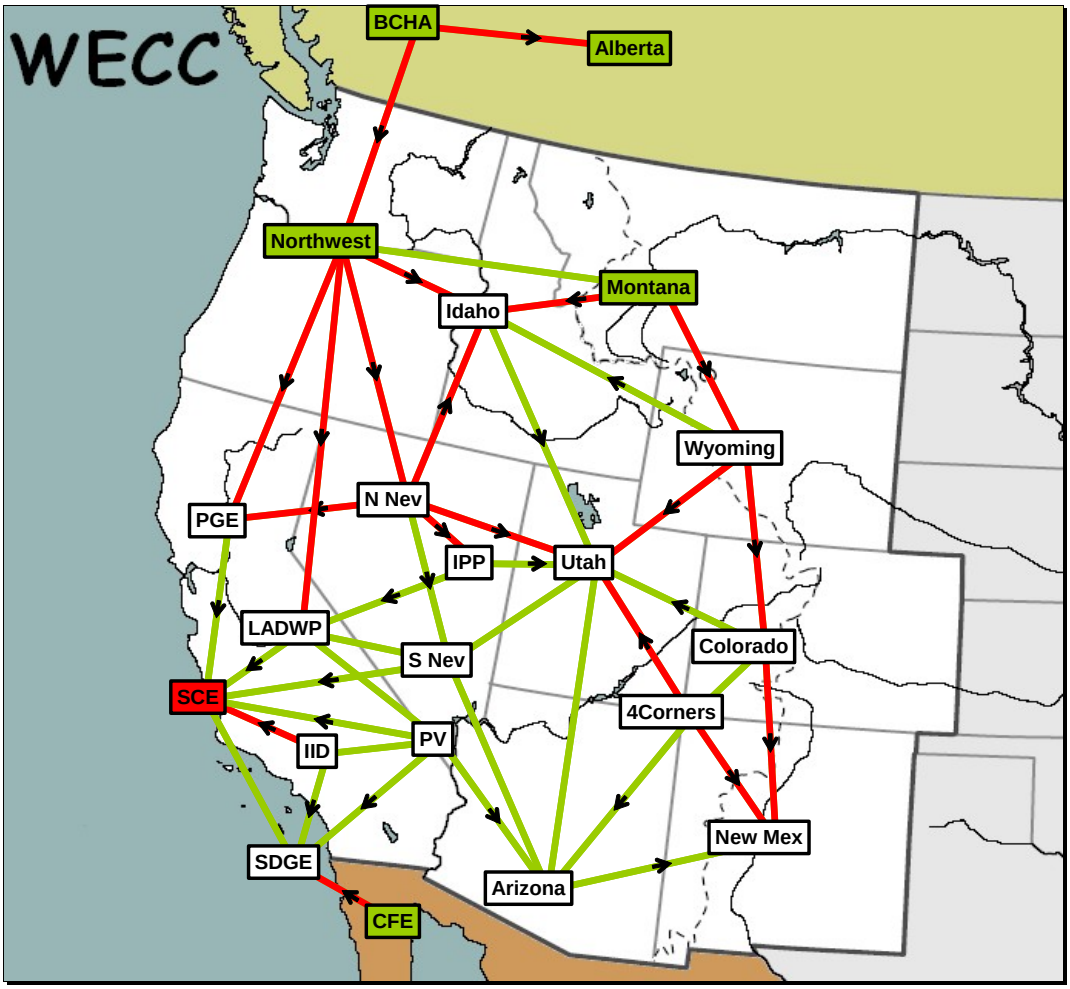


Scenario 1: Canada Renewables

Scenario 2: Northwest U.S. Renewables

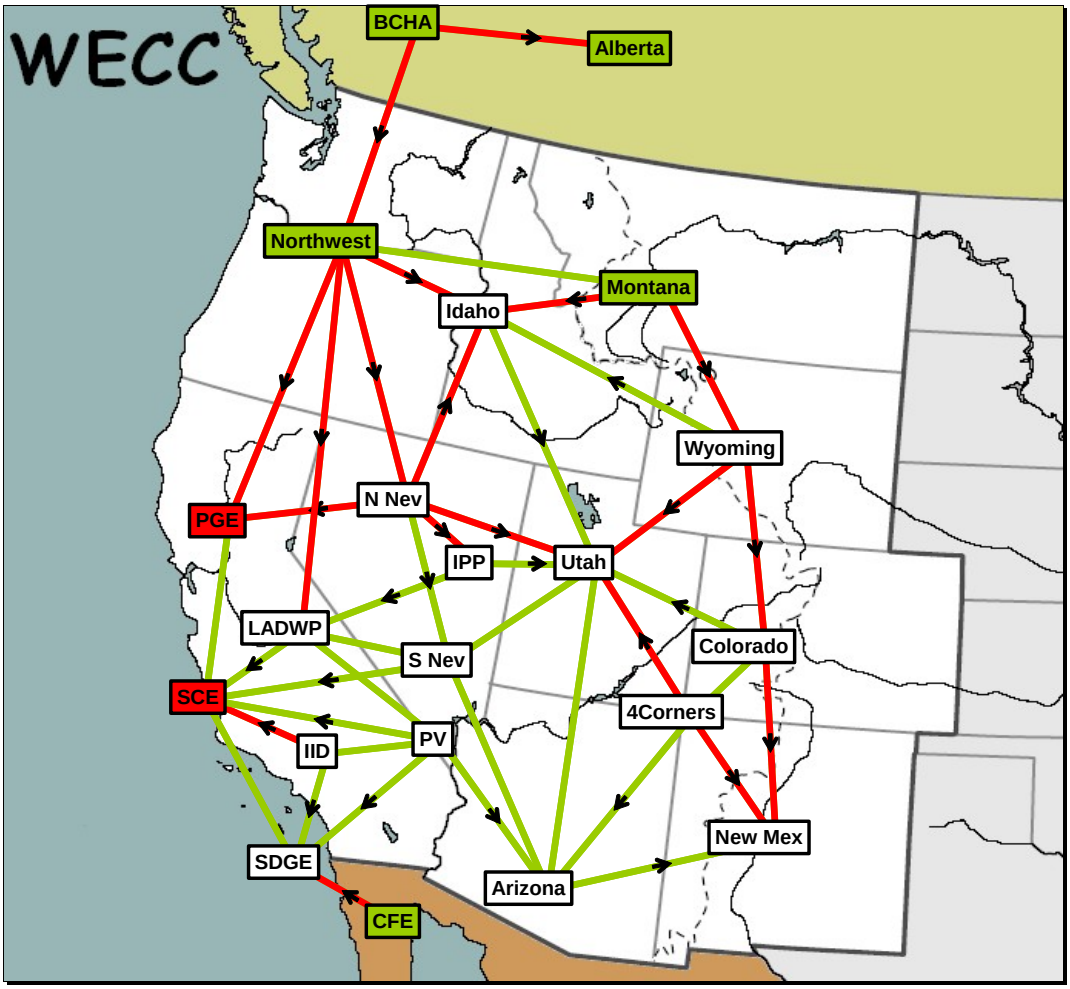
October 2007

Figure 3a: Scenario 2 - Canada Resources (Cases 1 and 2)



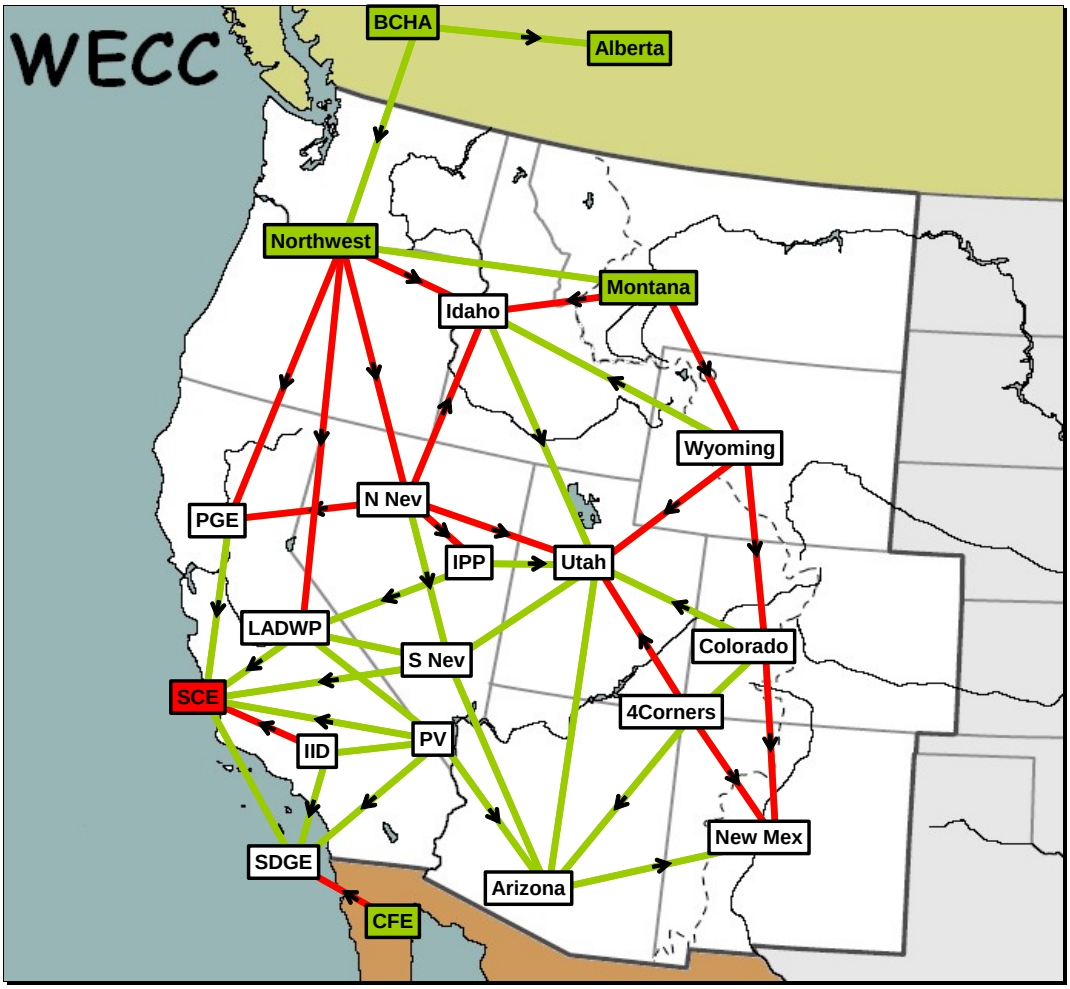
Key: Red zone – less than 15% reserve margin
Green zone – more than 15% reserve margin
White zone – exactly 15% reserve margin
Red line – path fully loaded in the direction of the arrow
Green line – path partially loaded in the direction of the arrow
Green line with no arrow – path with no flow

Figure 3b: Scenario 2 - Canada Resources (Case 3)



Key: Red zone – less than 15% reserve margin
Green zone – more than 15% reserve margin
White zone – exactly 15% reserve margin
Red line – path fully loaded in the direction of the arrow
Green line – path partially loaded in the direction of the arrow
Green line with no arrow – path with no flow

Figure 4: Scenario 3 - Northwest Renewables (all cases)



Key: Red zone – less than 15% reserve margin
Green zone – more than 15% reserve margin
White zone – exactly 15% reserve margin
Red line – path fully loaded in the direction of the arrow
Green line – path partially loaded in the direction of the arrow
Green line with no arrow – path with no flow

Table A-5. Reserve Margins[1] for the Three Scenarios

Reserve Margins by Zone							
Area	Target	Actual for Each Scenario					
		Scenario 1	Scenario 2			Scenario 3	
			Case 1	Case 2	Case 3	Case 1	Case 2
4Corners	15.0%	N/A	N/A	N/A	N/A	N/A	N/A
Alberta	15.0%	20.1%	31.6%	31.6%	31.6%	20.1%	20.1%
Arizona	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
BCHA	15.0%	35.2%	60.5%	60.5%	60.5%	35.2%	35.2%
CFE	15.0%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Colorado	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Idaho	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
IID	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
IPP	15.0%	N/A	N/A	N/A	N/A	N/A	N/A
LADWP	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Montana	15.0%	36.9%	36.9%	36.9%	36.9%	36.9%	36.9%
N Nev	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
New Mex	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Northwest	15.0%	41.6%	40.5%	40.5%	40.5%	44.9%	44.9%
PGE	15.0%	15.0%	15.0%	15.0%	11.7%	15.0%	15.0%
PV	15.0%	N/A	N/A	N/A	N/A	N/A	N/A
S Nev	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
SCE	15.0%	15.0%	9.8%	3.5%	1.3%	9.8%	3.5%
SDGE	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Utah	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Wyoming	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%

[1] The amounts and locations of the reserve margins indicated in this table are illustrative, and are shown here only to document study results.

Table A-6. Excess/Deficit Generation for the Three Scenarios and the Transportation Options, Dependable MW[2]

Scenario	Case	Transportation Option	Alberta	BCHA	Northwest	PGE	SCE
1			563	1,906	6,669	0	0
2	1	Status Quo	1,853	5,308	6,391	0	-1,224
		+1,500 MW Northwest → PGE	1,853	5,308	5,100	0	0
	2	Status Quo	1,853	5,308	6,391	0	-2,702
		+3,000 MW Northwest → PGE	1,853	5,308	3,540	0	0
		+3,000 MW BCHA → PGE	1,853	5,308	3,568	0	0
	3	Status Quo	1,853	5,308	6,391	-968	-3,226
		+4,500 MW Northwest → PGE	1,853	5,308	1,975	-968	0
3	1	Status Quo	951	1,906	7,478	0	-1,224
		+1,500 MW Northwest → PGE	563	1,906	6,579	0	0
	2	Status Quo	951	1,906	7,478	0	-2,702
		+3,000 MW Northwest → PGE	563	1,906	5,015	0	0

[2] These study results do not reflect the resource adequacy of any area or entity.

Table A-7. Loads and Resources Working Group Membership

name	company
Dennis Sullivan	PG&E
Curt Hatton	PG&E
Tom Miller	PG&E
Eric Law	PG&E
Robert Jenkins	PG&E
Rohan Soulsby	BCTC
Bill Hosie	NorthernLights Transmission/TransCanada
Don Bain	AeroPower Services
Jim McMorran	Sierra Pacific Power
Renee Hull	Sierra Pacific Power
Cam Matheson	BC Hydro
John Rich	BC Hydro
Kurt Granat	Pacificorp
Michael Margolick	NaiKun Wind Development
Gavin Berg	Katabatic Power
Tony Duggleby	Katabatic Power
Elroy Switlishoff	Jetson Consulting Engineers
Thom Fischer	Tollhouse Energy
Ed Chang	Flynn RCI
Elliot Mainzer	Bonneville Power Administration
Juergen Puetter	Aeolis Wind Power
Chris Reese	Puget Sound Energy