RENEWABLE ENERGY TRANSMISSION INITIATIVE

PHASE 2B

DRAFT REPORT
April 2010

RETI Coordinating Committee

Prepared for

RETI Coordinating Committee
RETI Stakeholder Steering Committee

RETI Stakeholder Steering Committee

Renewable Energy Transmission Initiative

RETI Phase 2B

DRAFT REPORT
B&V Project Number 149148

Contract Manager

University of California, Office of the President
California Institute for Energy and the Environment

April 2010

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1.0 Executive Summary

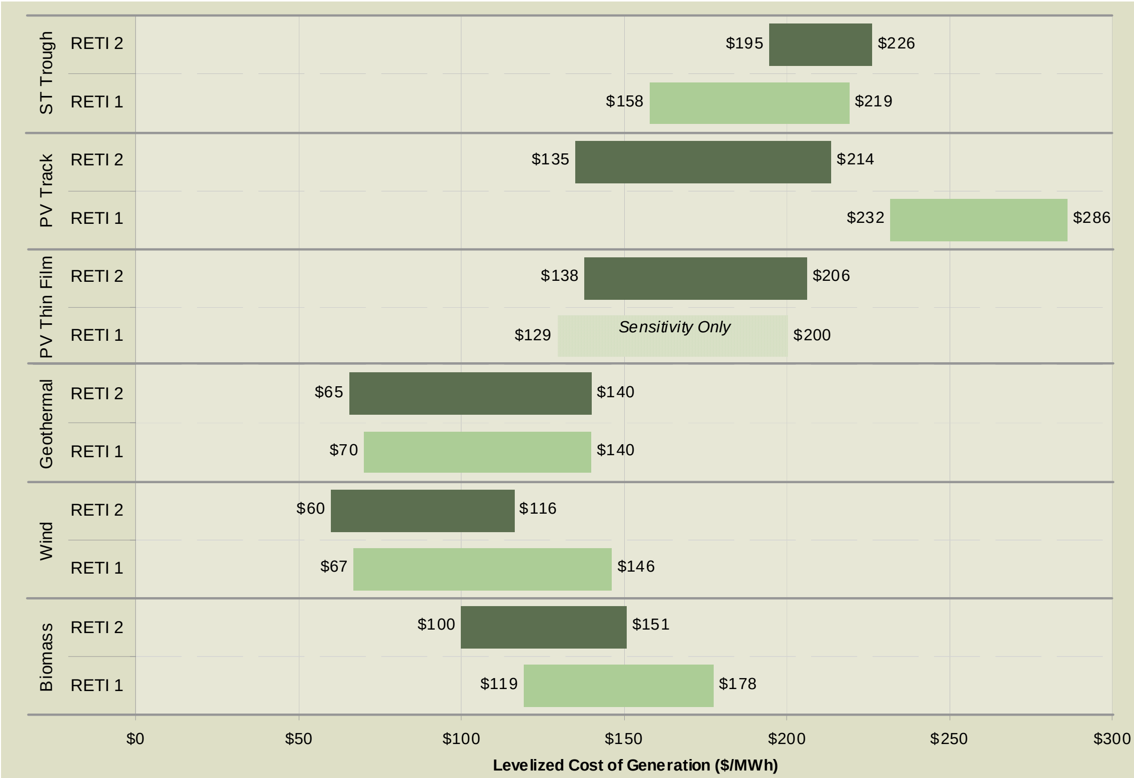
The Renewable Energy Transmission Initiative (RETI) is a statewide planning process to identify the transmission projects needed to accommodate California's renewable energy goals. Phases 1 and 2 of the RETI project resulted in the identification and refinement of Competitive Renewable Energy Zones (CREZs) that hold the greatest potential for cost-effective and environmentally responsible renewable development. Due to time constraints, several modifications to the RETI analysis were not included in the final Phase 2A report. This Phase 2B report documents key changes made in the economic model, technology assumptions, competitive renewable energy zones, and out-of-state (OOS) resources. This report considered these changes and updates the economic analysis of the CREZ.

A summary of the major changes and new results is provided in this Executive Summary.

1.1 Updates to Economic Model and Technology Assumptions

Changes were made to the economic model and key technology assumptions that affect the economic analysis. Several modifications were made to the cost of generation calculator to improve its accuracy and flexibility. Perhaps most importantly, the model now considers the expanded investment tax credit made available through the American Recovery and Reinvestment Act of 2009 for wind, geothermal and biomass technologies. In addition to new subsidies, substantial cost reductions in solar photovoltaic technology, and general changes in market conditions made it necessary to review and update the cost and performance assumptions for all technologies. The updated assumptions are provided in Section 4.

Based on the new model and the updated assumptions, Figure 1-1 shows the updated ranges of levelized cost of generation for the primary technologies included in RETI. The general estimates for RETI Phase 1B ("RETI 1") and the RETI Phase 2B ("RETI 2") are compared to give a sense of the magnitude of the changes. Except for solar thermal, the costs for technologies have generally dropped.



Note: PV Thin film previously only considered as a sensitivity case in RETI Phase 1B.

Figure 1-1. Typical Cost of Generation Ranges.

1.2 California CREZ Updates

Several changes and refinements have been made to the CREZs as part of the Phase 2B report. The proposed California Desert Protection Act has impacted several projects, and several CREZs have been refined based on input from the Phase 2B Workgroup and other stakeholders. While there were numerous reductions in CREZ capacity, the overall California CREZ capacity increased by about 3,000 MW compared to Phase 2A. This is primarily due to the addition of the new Westlands CREZ and the expansion of the Owens Valley CREZ. Table 1-1 shows the capacity estimates for each CREZ in Phase 2B. Additional details on the CREZ refinements are provided in Section 5.

Table 1-1. Phase 2B CREZ Capacity Estimates.

	Capacity, MW				
CREZ	**Biomass**	**Geothermal**	**Solar Thermal**	**Wind**	**Total**
Barstow			1,400	936	2,336
Carrizo North			1,600		1,600
Carrizo South			3,000		3,000
Cuyama			400		400
Fairmont	138		1,800	712	2,650
Imperial East			1,500	74	1,574
Imperial North-A		1,370			1,370
Imperial North-B	30		1,800		1,830
Imperial South	36	64	3,570	45	3,715
Inyokern			2,145	287	2,432
Iron Mountain			4,800	62	4,862
Kramer		24	6,185	203	6,412
Lassen North				1,467	1,467
Lassen South				410	410
Mountain Pass			780	178	958
Owens Valley			5,000		5,000
Palm Springs				333	333
Pisgah			2,200		2,200
Riverside East			10,550		10,550
Round Mountain-A		384			384
Round Mountain-B				132	132
San Bernardino - Baker			3,350		3,350
San Bernardino - Lucerne	91		1,540	599	2,230
San Diego North Central				200	200
San Diego South				678	678
Santa Barbara				433	433
Solano				894	894
Tehachapi	37		7,195	3,193	10,425
Twentynine Palms			1,805		1,805
Victorville			1,200	436	1,636
Westlands			5,000		5,000
Grand Total	**332**	**1,842**	**66,820**	**11,273**	**80,267**

1.3 Out-of-state Resources

RETI Phase 1B only included a limited review of out-of-state (OOS) resources. Updated data from the Western Renewable Energy Zones (WREZ) project was considered to expand and improve the consideration of OOS resources in the Phase 2B report. Figure 1-2 shows a map of all of the resources that are now included in the RETI Phase 2B model. Table 1-2 summarizes the capacity estimates for the OOS resources.

The economics of these OOS resources, including the associated transmission costs to deliver the energy to California, is included in the updated economic model.

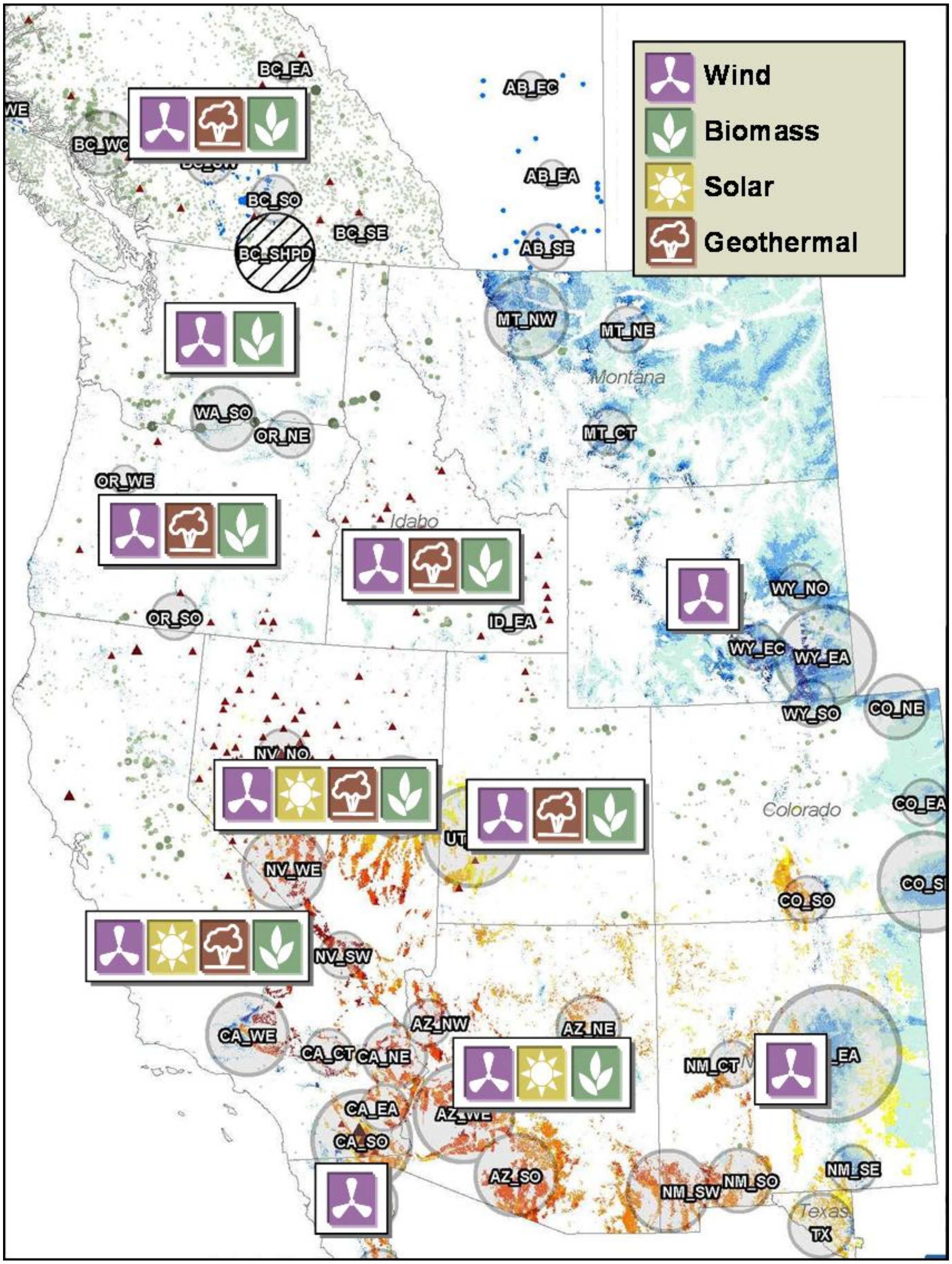


Figure 1-2. Resources Included in RETI Phase 2A.

Table 1-2. Out-of-State Resource Estimates (MW).

Region	Biomass	Geothermal	Solar	Wind	Total
AZ	329		19,782	3,714	23,825
BC	939	340		13,942	15,221
BJ				8,305	8,305
ID	358	329		1,649	2,336
NM				13,186	13,186
NV	299	1,459	18,588	1,754	22,099
OR	454	403		2,913	3,770
UT	90	375		1,679	2,144
WA	449			3,262	3,711
WY				14,853	14,853
Total	**2,918**	**2,906**	**38,370**	**65,257**	**109,451**

Notes: Oregon geothermal in WREZ includes northern California resources which were removed to prevent double counting. Geothermal projects already under contract to NV Energy were also removed. Solar estimate is for either PV or solar thermal which were estimated to have the same capacity in each hub in the WREZ process.

All of the resources in Alberta, Montana and Colorado were screened out of the analysis since there appear to be lower cost resource options in adjacent states.

1.4 Results

Based on the inputs identified in the previous sections, Black & Veatch developed updated rank costs for each resource identified in RETI. The rank costs were aggregated into weighted average rank costs for each CREZ, and were also used to develop supply curves for each CREZ. In addition, the resource supply curves were subjected to uncertainty and sensitivity analyses to determine if the curves fairly represented a robust range of resource costs. Finally, the updated economic analysis results were integrated with revised environmental scores.

1.4.1 CREZ Rank Cost

Table 1-3 provides the weighted average ranking cost of each CREZ in California and the out-of-state resource areas. The out-of-state resource areas are highlighted in yellow. The rank cost for a resource includes the cost of generation and transmission, less the capacity and energy value.[1] CREZ rankings as presented in Table 1-3 do not include the uncertainty bands discussed later in this report, but they can be seen in Figure 1-4.

[1] All dollar amounts in this report are in 2010 dollars, unless otherwise stated. Further, unless otherwise stated, all economic figures in this report represent the midpoint of a range of costs, as discussed further in the uncertainty analysis in Section 7.

Table 1-3. Weighted Average Rank Costs: All CREZ and Resource Areas.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)*	Cumulative Energy (GWh/yr)*	Weighted Average Rank Cost ($/MWh)
Solano	894	2,721	2,721	-21
Palm Springs	333	1,047	3,768	-18
Round Mountain-A	384	2,557	6,325	-6
Imperial North-A	1,370	10,095	16,419	4
Santa Barbara	433	1,121	17,540	4
Fairmont	2,200	6,015	23,555	7
San Diego South	678	1,829	25,385	9
Tehachapi	8,626	21,411	46,795	11
San Diego North Central	200	502	47,297	15
Lassen South	410	1,051	48,348	18
Victorville	1,336	3,196	51,545	18
Round Mountain-B	132	339	51,883	19
Barstow	1,986	4,706	56,589	19
UT_WE	2,144	7,595	64,184	20
San Bernardino - Lucerne	1,845	4,829	69,013	21
Lassen North	1,467	3,595	72,608	24
Kramer	4,866	11,092	83,700	25
OR_SO	669	2,443	86,143	25
Inyokern	1,896	4,315	90,459	29
OR_WE	970	5,393	95,851	29
NV_NO	1,248	8,389	104,240	30
Mountain Pass	763	1,741	105,982	32
Twentynine Palms	1,354	3,012	108,993	33
Pisgah	1,650	3,680	112,673	34
Cuyama	300	638	113,311	35
OR_NE	2,089	5,719	119,031	35
Carrizo South	2,250	4,721	123,751	38
San Bernardino - Baker	2,513	5,540	129,291	38
Carrizo North	1,200	2,501	131,792	38
Imperial East	1,199	2,708	134,500	41
Riverside East	7,913	17,504	152,004	41
Westlands	3,750	7,467	159,472	42
ID_SW	1,158	3,906	163,378	45
WY_EC	2,595	8,236	171,614	45
AZ_NE	4,063	11,694	183,308	46
NV_SW	5,042	12,501	195,809	49
WA_SO	3,752	11,942	207,751	51
Imperial North-B	1,380	3,190	210,941	53
Imperial South	2,823	6,714	217,655	54
ID_EA	1,178	4,934	222,589	54
Owens Valley	3,750	8,194	230,782	56
BJ_NO	5,655	16,635	247,417	56
WY_SO	1,940	5,813	253,230	57
AZ_NW	3,758	9,168	262,397	58
NM_EA	11,292	31,626	294,023	58

Table 1-3. Weighted Average Rank Costs: All CREZ and Resource Areas.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)*	Cumulative Energy (GWh/yr)*	Weighted Average Rank Cost ($/MWh)
AZ_WE	9,373	23,130	317,153	58
WY_NO	3,061	9,217	326,369	58
NV_WE	7,836	20,109	346,479	61
WY_EA	7,257	22,690	369,169	62
Iron Mountain	3,662	8,133	377,302	64
NM_SE	1,894	5,376	382,678	65
BJ_SO	2,650	7,973	390,651	73
NV_EA	7,974	19,332	409,984	73
AZ_SO	6,631	16,265	426,249	76
BC_WC	307	2,121	428,370	95
BC_EA	66	429	428,799	130
BC_SE	230	829	429,627	140
BC_WE	1,370	3,194	432,821	142
BC_NE	4,206	10,638	443,459	148
BC_SW	1,922	4,424	447,883	155
BC_SO	2,441	5,208	453,092	157
BC_NO	2,254	5,486	458,577	161
BC_CT	1,024	2,497	461,074	176
BC_NW	1,402	3,442	464,516	185

Note:
* Includes transmission losses

Generally, the relative economic rankings of the CREZs are comparable to previous RETI results. Compared to RETI Phase 1B, the top five CREZs are the same, except that Santa Barbara replaces the Victorville CREZ. Wind-dominated CREZs did comparatively better than solar-dominated CREZs, largely due to the new 30 percent grant / ITC assumed to be available for wind (solar had already been eligible for the ITC). The out-of-state resources are generally higher cost than the in-state resources, largely due to higher assumed transmission costs.

Figure 1-3 depicts the all the resources in the Phase 2B report by cost and resource quantity. Considering the net short of about 50,000 GWh, this figure shows that California has sufficient resource to meet its renewable energy goals, albeit at increasingly higher costs of development. This figure also includes out-of-state resources for comparison. Some of these resources may be cost competitive with California CREZs.

1.4.2 Uncertainty and Sensitivity Analysis

It is very important to consider the uncertainty in the estimates used to quantify and value resources. By their very nature, these estimates include a margin of error due to the assumptions made by the RETI team. In addition to general uncertainty, there are wide variety of plausible future scenarios which may affect the modeling results and the ranking of the CREZs. An uncertainty and sensitivity assessment was carried out to identify which CREZs and resources areas might be economically viable under certain situations. In addition to a general uncertainty assessment, sensitivity studies were performed to investigate the impacts of several key issues, such as:

- Tax credits
- Out-of-state transmission costs
- Shaping and firming of resources (British Columbia example)
- Advanced solar thermal technologies costs
- Distributed solar photovoltaics

For further information on the results of these analyses, please refer to Section 7. The supply curve in Figure 1-3 is shown again with uncertainty bands in Figure 1-4.

1.4.3 Combined Environmental and Economic Ranking

Black & Veatch re-ranked the CREZ using the same process as outlined in Phase 1B of RETI. The economic scores identified in this section were used for the updated economic ranks. Based on the new CREZ descriptions, updated environmental scores were calculated employing the same process described in the Phase 1B Report.

The bubble chart below in Figure 1-5 shows revised CREZ assessments in terms of relative economic cost and environmental concerns per unit energy produced. As in the Phase 1B Report, CREZ to the left in this chart are expected to have fewer environmental concerns per unit energy production, and CREZ toward the bottom are expected to have lower cost/higher economic value per unit energy. Since comparable environmental data is not available, out-of-state areas are not shown on this chart.

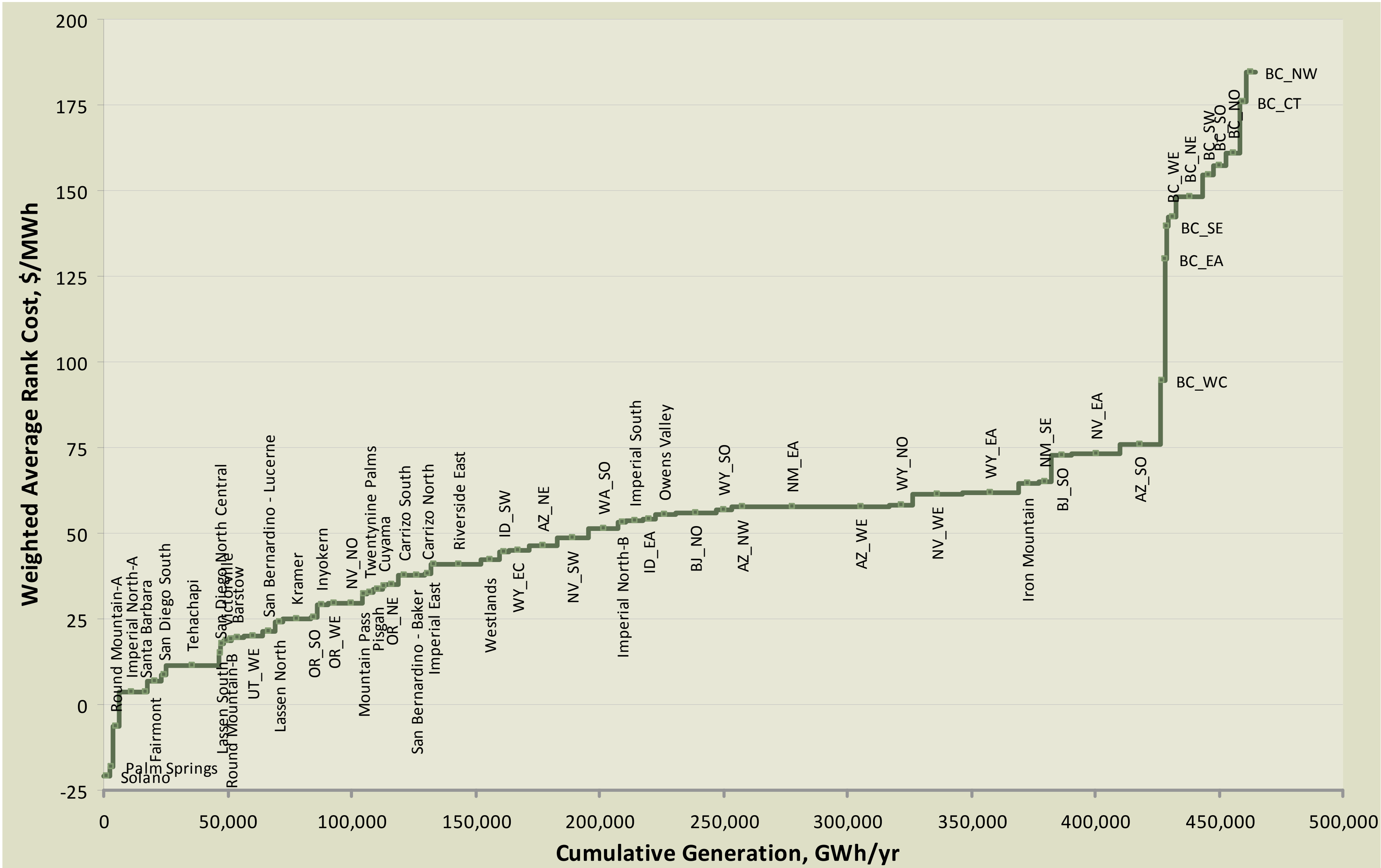


Figure 1-3. Weighted Average Rank Cost (2010 $/MWh) for CREZs.

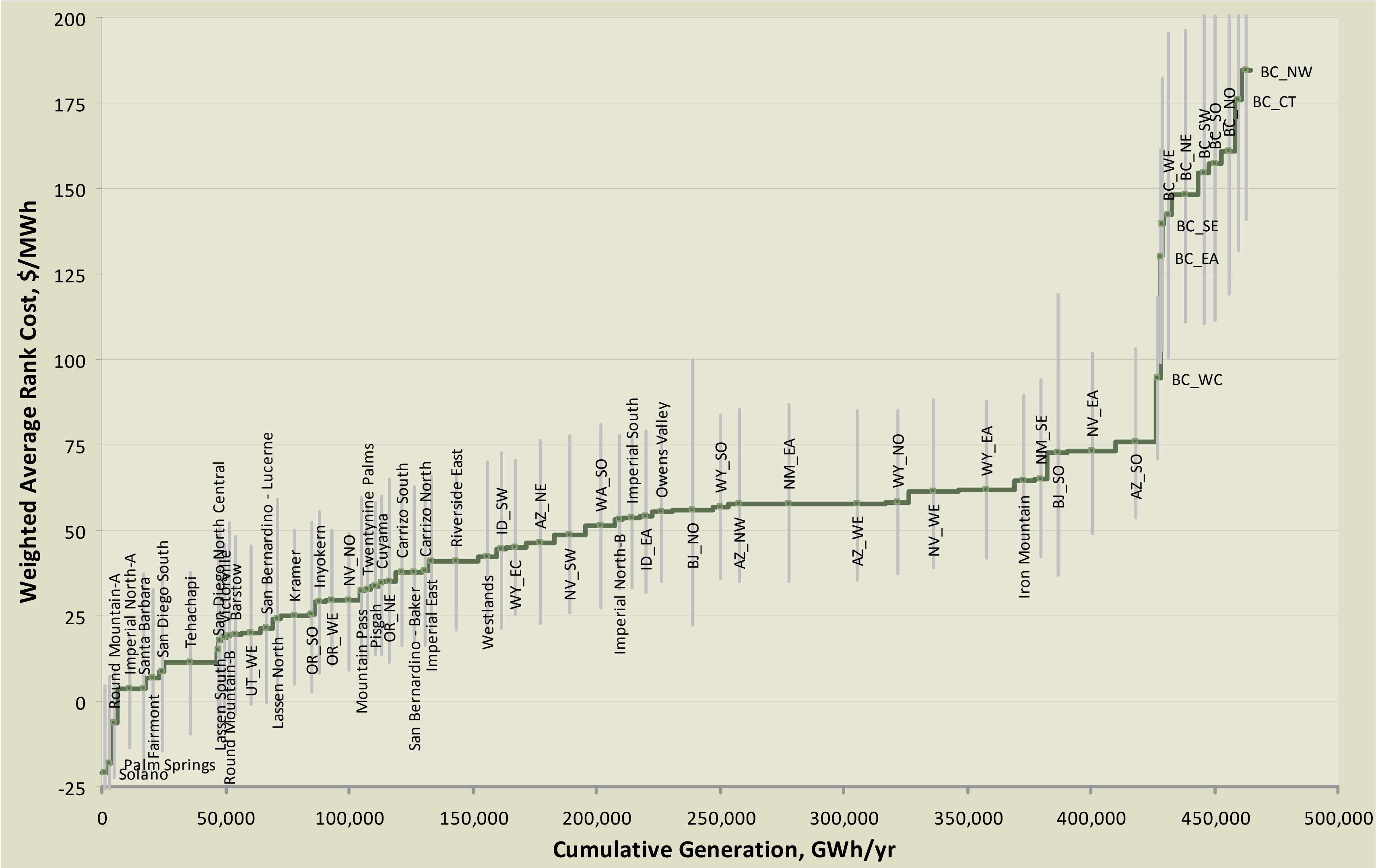
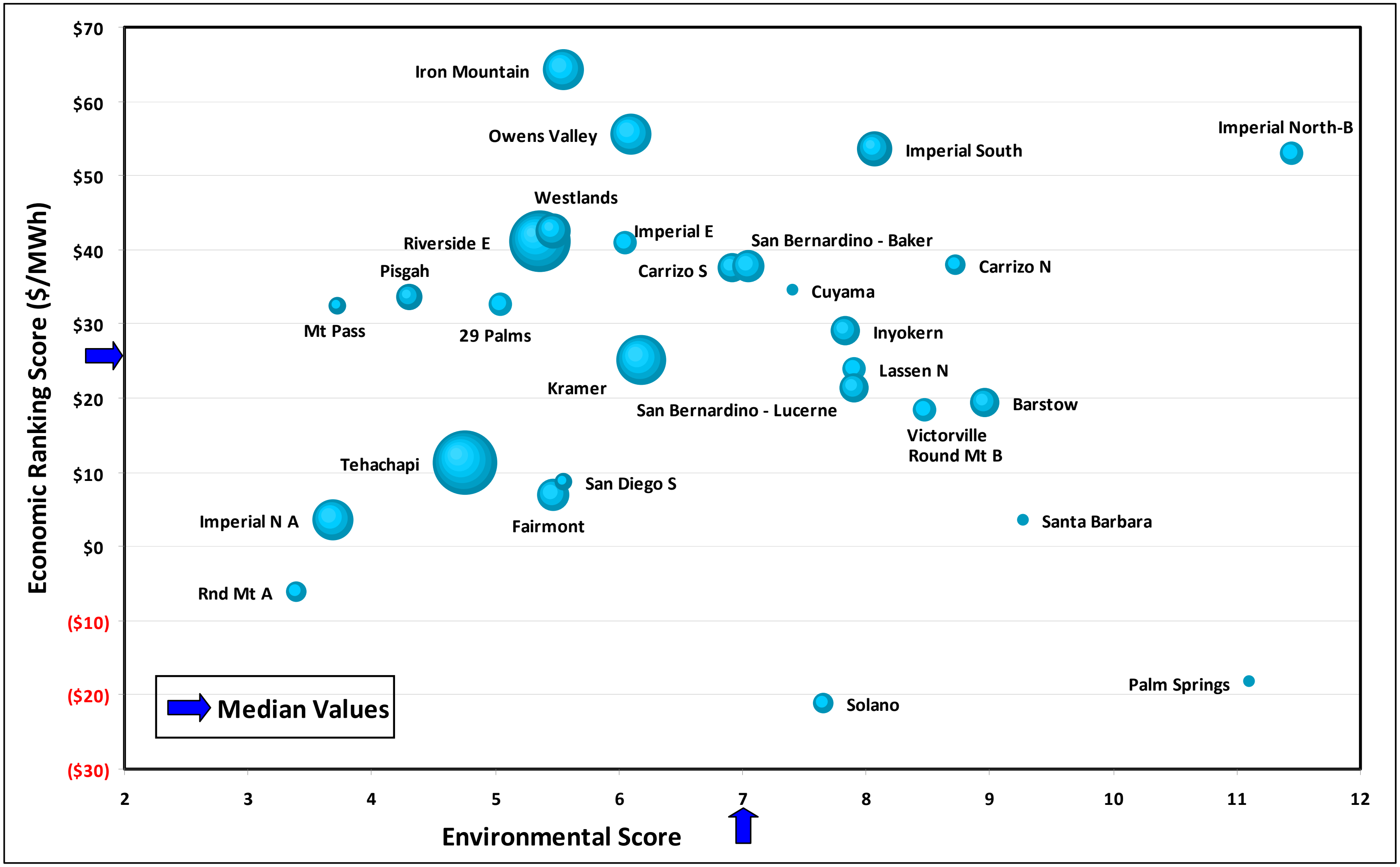


Figure 1-4. Weighted Average Rank Cost (2010 $/MWh) for CREZs with Uncertainty.



Notes:

- Areas of the bubbles are proportional to CREZ energy.
- Lassen South CREZ is off the right side of the chart. (Economic Score = 18, Environmental Score = 19.50, Energy = 1051 GWh)
- San Diego North Central CREZ is off the right side of the chart. (Economic Score = 15, Environmental Score = 22.3, Energy = 502 GWh)
- Victorville and Round Mountain-B are coincident

Figure 1-5. CREZ Economic and Environmental Scores Phase 2B, Bubble Chart.

2.0 Introduction

The objective of this Phase 2B report is to update the economic analysis performed in Phase 1B and Phase 2A of the California Renewable Energy Transmission Initiative project. This report documents key changes made in the economic model, technology assumptions, competitive renewable energy zones, and out-of-state (OOS) resources. This report considered these changes and updates the economic analysis of the CREZ.

2.1 Background

California has adopted energy policies that require substantial increases in the generation of electricity from renewable energy resources. Implementation of these policies will require extensive improvements to California's electric transmission infrastructure. The Renewable Energy Transmission Initiative (RETI) is a statewide planning process to identify the transmission projects needed to accommodate these renewable energy goals.

RETI Phase 1 involved a thorough technological assessment of potential renewable resources in California and adjoining states, resulting in the identification of those areas, called Competitive Renewable Energy Zones (CREZs) that hold the greatest potential for cost-effective and environmentally responsible renewable development. RETI Phase 2 includes refinement of much of the original Phase 1 effort with the ultimate goal of identifying preferred transmission lines accessing CREZs.

Due to time constraints, several modifications to the RETI analysis were not included in the final Phase 2A report. These include incorporating comments, accounting for recent changes in U.S. economic incentives for renewables, and extending resources to the Western Interconnect based on work done for other projects. In addition, project costs and characteristics were updated. This report describes the additional work that was required to implement these updates.

2.2 Previous Reports and Documentation

This report relies on various work products that have been previously published as part of the RETI and Western Renewable Energy Zones (WREZ) projects. These include:

- "RETI Phase 1B Final Report", January 5, 2009, available at: http://www.energy.ca.gov/reti/documents/index.html.
- "RETI Phase 2A Final Report and Appendices - Second Revision", September 23, 2009, available at: http://www.energy.ca.gov/reti/documents/index.html.

- "Western Renewable Energy Zones, Phase 1: QRA Identification Technical Report", October 2009, available at: http://www.nrel.gov/docs/fy10osti/46877.pdf.
- "WREZ Transmission Model", 2009, available at: http://www.westgov.org/index.php?option=com_content&view=article&catid=102%3Ainitiatives&id=221%3Awrez-generation-and-transmission-modeling&Itemid=81

The members of the Phase 2B Workgroup generously provided their time to review the assumptions, methodology and analysis that went into this report. The workgroup consists of industry representatives, developers, utilities, and other interested stakeholders. Various meeting materials and interim work products for the RETI Phase 2B Workgroup are available at:

- http://www.energy.ca.gov/reti/steering/workgroups/phase2A_update/.

2.3 Interaction with other Processes and Decisions

Many initiatives are underway in California to advance renewables besides RETI, and this report presents just one aspect of an interconnected process. Other notable initiatives and decisions underway include:

- California Transmission Planning Group
- California Desert Renewable Energy Conservation Plan
- Renewable Distributed Energy Collaborative
- Tradable Renewable Energy Credits

2.3.1 California Transmission Planning Group

Information to be included in the Final Report.

2.3.2 California Desert Renewable Energy Conservation Plan

Information to be included in the Final Report.

2.3.3 Renewable Distributed Energy Collaborative

Previous RETI work has recognized the potential for large amounts of renewable distributed generation (DG) to contribute to California's renewable energy needs. The objective of the Renewable Distributed Energy Collaborative (Re-DEC) is to identify challenges and potential solutions to high penetration of distributed generation.

Re-DEC was formed by the CPUC to explore and better understand challenges faced by developers and utilities with integrating large amounts (e.g., 15,000 MW) of renewable DG into the electricity distribution system in California. Re-DEC generally focuses on wholesale DG connected to the distribution system, on the utility side of the meter, and ranging in size from 1 to 5 MW. Since RETI is generally focused on larger scale-transmission dependent renewables, Re-DEC provides an important complementary function. For more information on Re-DEC, please refer to:

- http://www.cpuc.ca.gov/PUC/energy/Renewables/Re-DEC.htm

2.3.4 Tradable Renewable Energy Credits

The CPUC recently passed D.10-03-021 allowing California's retail sellers to use Tradable Renewable Energy Credits (TRECs). The decision classifies which transactions will be considered bundled and which will be considered TREC transactions, and it limits the three large utilities' use of TRECs to up to 25 percent of their 2010-2011 annual RPS requirements. The 25 percent limit, as well as a REC price cap of $50/MWh, will expire on December 31, 2011 and may be re-examined based on market experience. The use of TRECS could have a significant effect on the need for transmission; however, given the time constraint and the uncertainty on the actual use, scope and effectiveness of TRECs, RETI has made no attempt to include them in this analysis.

2.4 Report Organization

Following this Introduction, this report is organized into the following sections:

- **Section 3 – Economic Model Updates:** Several modifications have been made to the Cost of Generation Calculator in order to improve its accuracy and flexibility. In addition, the American Recovery and Reinvestment Act of 2009 has changed the incentives available for renewables in the U.S. This section describes the changes that have been made to accommodate this new policy, as well as the changes in the incentive assumptions for Canada and Mexico now that they differ significantly from those used in the U.S.
- **Section 4 – Technology Assumption Adjustments:** New subsidies available to wind, geothermal and biomass, substantial cost reductions in solar photovoltaic technology, and general changes in market conditions have made it necessary to review and update the cost assumptions for all technologies. In addition, performance characteristics have been updated to improve accuracy and to take advantage of the availability of new modeling software. This section covers these changes to technology cost and performance characteristics.

- **Section 5 – California CREZ Updates:** Several changes and refinements have been made to the CREZs as part of the Phase 2B report. The proposed California Desert Protection Act has impacted several projects, which have been listed here. In addition, several of the CREZs have been refined based on input from the Phase 2B Workgroup and other stakeholders. This section describes these changes by CREZ, and shows the impacts of these changes on overall generating capacity.
- **Section 6 – Out-of-state Additions and Improvements:** Several additions and improvements have been made to the out-of-state resource analyses to address previous concerns and also to take advantage of better resource information made available in other recent studies. This section describes all of the changes made to the out-of-state (OOS) resources, including the new out-of-state transmission cost approach.
- **Section 7 – Results:** Based on the inputs identified in the previous sections, Black & Veatch developed updated rank costs for each resource identified in RETI. The rank costs were aggregated into weighted average rank costs for each CREZ, and were also used to develop supply curves for each CREZ. In addition, the resource supply curves were subjected to uncertainty and sensitivity analyses to determine if the curves fairly represented a robust range of resource costs. Finally, the updated economic analysis results were integrated with revised environmental scores.

2.5 Accompanying Data and Map

In conjunction with this report, Black & Veatch has developed detailed complementary data and maps, including:

- Project characteristics spreadsheet
- California CREZ map
- Baja California wind map
- California CREZ shapefiles
- CREZ Google Earth Files

The data is available for download at the project website: www.energy.ca.gov/reti.

3.0 Economic Model Updates

RETI compares the economics of different resources using the rank cost metric. Rather than comparing projects on the levelized cost of generation alone, the rank cost includes the cost of generation and the cost of transmission and also considers the energy and capacity values of the generation profile of the project. The methodology for rank cost calculation is generally unchanged from RETI Phase 1B. However, the Phase 2B report includes changes to the cost of generation calculator, as described in this section.

Several modifications have been made to the Cost of Generation Calculator in order to improve its accuracy and flexibility. In addition, the American Recovery and Reinvestment Act of 2009 has changed the incentives available for renewables in the U.S. This section describes the changes that have been made to accommodate this new policy, as well as the changes in the incentive assumptions for Canada and Mexico now that they differ significantly from those used in the U.S.

3.1 Rank Cost Overview

Since Phase 1, RETI has used a rank cost metric to evaluate economics of resources. The generation cost, transmission cost, capacity value, and energy value are combined in a single cost metric that represents the overall economic merit of a given project or CREZ. This is known as the rank cost. The rank cost is calculated using the following formula:

Rank Costs =
Generation Cost + Transmission Cost + Integration Cost
- Energy Value - Capacity Value

The rank cost represents the costs of a renewable energy resource above (or below) its energy and capacity value. A lower ranking cost (including negative values), is indicative of a more cost-effective renewable energy project.

The costs of generation have been updated for Phase 2B, as outlined below. The approach for energy value and capacity value remain generally unchanged.[2] The in-state transmission costs are based on the same shift factor approach used in Phase 2A, and a new methodology for out-of-state transmission costs has been developed. Transmission costs are discussed more in depth in Section 6. Integration costs are another component that have been considered for inclusion in the rank cost, but data on integration costs that

[2] RETI Phase 1 considered capacity values of $204/kW-yr and $102/kW-yr. The mean value was used for this update: $153/kW-yr.

are appropriate for application in RETI is still unavailable. Therefore, no integration costs have been incorporated into the rank costs at this time.

3.2 Cost of Generation Calculator Improvements

Following is a list of changes that have been made to the Cost of Generation calculation, which is shown in Figure 3-1.

- All technologies in the U.S. are now considered eligible for the 30 percent investment tax credit (ITC) or equivalent grant.
- The ITC is now modeled as a capital cost reduction, not a year 1 windfall. This more appropriately reflects the ARRA "ITC Grant".
- The model now allows for a mix of depreciation schedules. This better reflects tax code and better mimics foreign depreciation rules.
- Includes additional revenue streams which allows for more flexibility in modeling incentives.
- The model now allows for a direct input for performance degradation over time. This mostly affects solar PV projects.

The model was reviewed with the Phase 2B Workgroup and is available on the RETI web page. While improvements have been made to the model, it is still important to note that it is a screening model intended primarily for use as part of the RETI process. There are many simplifications in the model which constrain its use. Those interested in using the model should refer to the original documentation, available at:

- http://www.energy.ca.gov/reti/steering/2008-06-18_meeting/2008-06-18_B+V_Cost_of_Genenenation_information.pdf

Technology Assumptions	
Project Capacity (MW)	1
Capital Cost ($/kW)	$2,500
Fixed O&M ($/kW)	$60
Fixed O&M Escalation	2.5%
Variable O&M ($/MWh)	$0
Variable O&M Escalation	2.5%
Fuel Cost ($/MBtu)	$0
Fuel Cost Escalation	2.5%
Heat Rate (Btu/kWh)	0
Capacity Factor	35%
Misc Revenue ($/MWh)	$0
Misc Escalation	2.5%
Degradation	0%

Financial/Economic Asumptions	
Debt Percentage	60%
Debt Rate	7.50%
Debt Term (years)	15
Economic Life (years)	20
Percent 5-year MACRS	100%
Percent 7-year MACRS	0%
Percent 15-year MACRS	0%
Percent 20-year MACRS	0%
Energy Price Escalation	2.5%
Tax Rate	40%
Cost of Equity	15.00%
Discount Rate	10.500%

Incentives	
PTC ($/MWh)	$0
PTC Escalation	0.0%
PTC Term (years)	10
ITC	30%
ITC Depr Basis	85%

Outputs	
NPV Equity Return	$0
LCOE	$82.59

Calculation		
Cap Cost		$1,750,000
	0	
	0	-805479.0356
	5	-747899.2307
slope		11515.96099

Year		1	2	3	4	5	6	7	8	9	10	11	12	13
Annual Generation (MWh)		3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066	3,066
Power Price		$69.94	$71.69	$73.49	$75.32	$77.21	$79.14	$81.11	$83.14	$85.22	$87.35	$89.53	$91.77	$94.07
Misc Revenue		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Operating Revenue		**$214,450**	**$219,811**	**$225,307**	**$230,939**	**$236,713**	**$242,631**	**$248,696**	**$254,914**	**$261,287**	**$267,819**	**$274,514**	**$281,377**	**$288,412**
Fixed O&M		$60,000	$61,500	$63,038	$64,613	$66,229	$67,884	$69,582	$71,321	$73,104	$74,932	$76,805	$78,725	$80,693
Variable O&M		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fuel Cost		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Operating Expenses		**$60,000**	**$61,500**	**$63,038**	**$64,613**	**$66,229**	**$67,884**	**$69,582**	**$71,321**	**$73,104**	**$74,932**	**$76,805**	**$78,725**	**$80,693**
Interest Payment		$78,750	$75,735	$72,494	$69,009	$65,264	$61,237	$56,908	$52,255	$47,253	$41,876	$36,095	$29,881	$23,200
Principal Payment		$40,202	$43,217	$46,458	$49,942	$53,688	$57,715	$62,043	$66,696	$71,699	$77,076	$82,857	$89,071	$95,751
Debt Service		**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**	**$118,952**
Tax Depreciation - 5		$425,000	$680,000	$408,000	$244,800	$244,800	$122,400	$0	$0	$0	$0	$0	$0	$0
Tax Depreciation - 7		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tax Depreciation - 15		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Tax Depreciation - 20		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income		($349,300)	($597,424)	($318,225)	($147,483)	($139,580)	($8,891)	$122,206	$131,337	$140,929	$151,011	$161,614	$172,771	$184,518
PTC		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxes		**($139,720)**	**($238,969)**	**($127,290)**	**($58,993)**	**($55,832)**	**($3,556)**	**$48,883**	**$52,535**	**$56,372**	**$60,405**	**$64,646**	**$69,109**	**$73,807**
Total	***(700,000)***	***175,218***	***278,329***	***170,607***	***106,368***	***107,364***	***59,351***	***11,281***	***12,106***	***12,859***	***13,531***	***14,112***	***14,592***	***14,959***

Figure 3-1. Cost of Generation Calculator (first 13 years only).

3.3 Incentives Assumptions

In February 2009, the American Recovery and Reinvestment Act of 2009 (ARRA) was signed into law. This act includes several provisions specifically designed to encourage the development of renewable energy such as including improvements to tax incentives that lower the cost of renewables. Most importantly, ARRA allows for biomass, geothermal, and wind projects to now take advantage of the 30 percent investment tax credit (ITC) or equivalent grant. Previously these technologies were only eligible for the production tax credit. The cost of generation model evaluates each resource under various incentive assumptions and picks the lowest cost. As with RETI Phase 1B, it has been assumed that these subsidies are available throughout the study term (until 2020).

Figure 3-2 shows the general impacts of the PTC and ITC subsidies on different renewable technologies using generic technology assumptions.

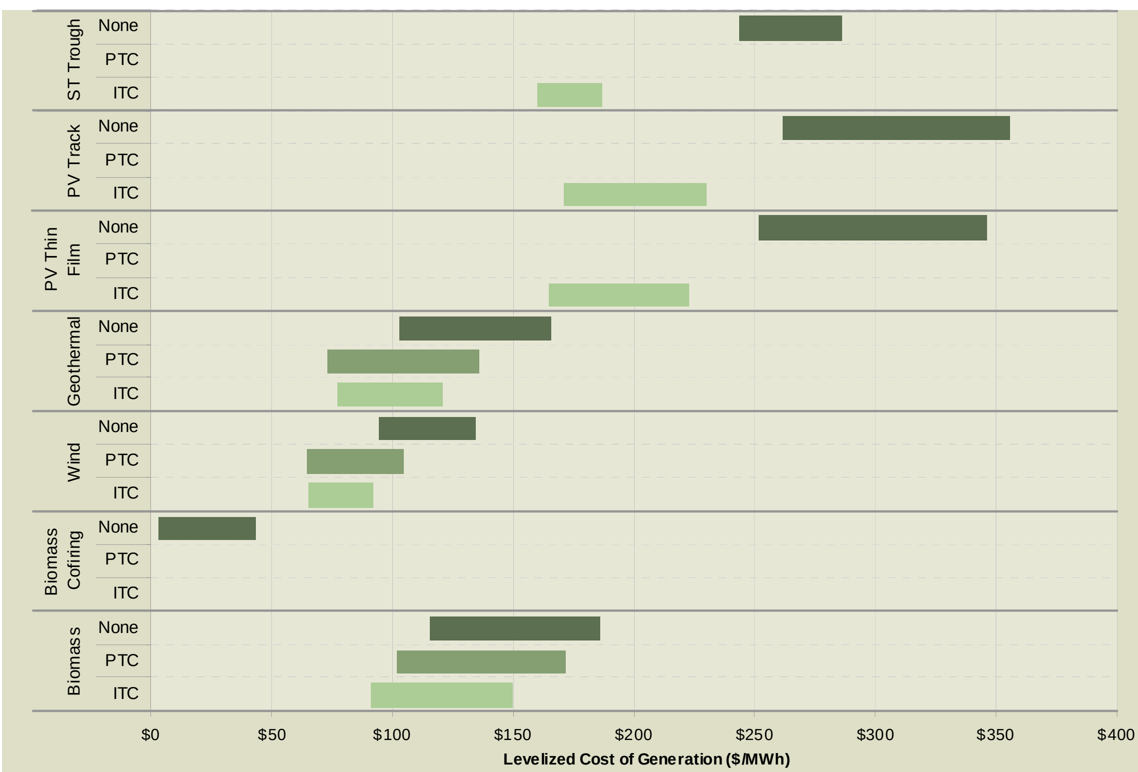


Figure 3-2. Impact of PTC and ITC on Cost of Renewables.

The economic incentives in Canada and Mexico were assumed to be similar to those in the U.S. in RETI Phase 1B. Due to the recent changes to U.S. incentives, the economic incentives for Canada and Mexico are no longer similar enough to those of the U.S. and need to be incorporated separately. The following sections describe the Canadian and Mexican incentives that were included in the model.

3.3.1 Canadian Incentives

The Canadian federal government has two applicable incentive programs for renewable energy. First, it offers an accelerated depreciation program for renewable energy, the Capital Cost Allowance (CCA) 43.2. This incentive grants geothermal, wind and small hydropower resources a 50 percent declining accelerated depreciation benefit. It grants conventional, large hydropower a 30 percent declining accelerated depreciation benefit. In each case, the depreciation rate is halved for the first year. Black & Veatch determined that the Canadian 50 percent CCA accelerated depreciation schedule and the 30 percent CCA for renewable energy have a similar effect on the net present value of a project as the U.S. MACRS depreciation schedules. As a result, all technologies that qualify for the 50 percent CCA were modeled with the 5-year MACRS depreciation schedule, and all technologies that qualify for the 30 percent CCA were modeled with the 7-year MACRS depreciation schedule.

Canada also has an incentive program called EcoENERGY which provides a $10/MWh (CDN) incentive payment for 10 years. However, this was not included because the funds allocated for the program have been exhausted and Canadian representatives as part of the WREZ process did not feel it was likely to be replenished in the near-term. Therefore, the only incentives that were applied to Canadian renewable energy resources were the MACRS 5-year depreciation schedules that mimic the CCA schedules.

3.3.2 Mexican Incentives

Mexico has several incentives for renewable energy development including 95 percent one-year accelerated depreciation, potential for Kyoto Protocol Clean Development Mechanism carbon credits at rates not available to U.S. projects, favorable export credit treatment from organizations such as the U.S. Export Import Bank, and other incentives.[3] The potential for Clean Development Mechanism credits were not modeled directly. However, the 95 percent 1 year depreciation was mimicked using the models for the U.S. incentives. It was determined that this could be mimicked by granting Mexican projects zero depreciation but providing them a tax credit in the first year equal to 95 percent of their tax liability. Given the lower income tax rates in Mexico, this is functionally modeled as a 26.6 percent ITC.

[3] Personal communication from James Walker, Asociados Panamericanos, April 23, 2008

4.0 Technology Assumption Adjustments

New subsidies available to wind, geothermal and biomass, substantial cost reductions in solar photovoltaic technology, and general changes in market conditions have made it necessary to review and update the cost assumptions for all technologies. In addition, performance characteristics have been updated to improve accuracy and to take advantage of the availability of new modeling software. This section covers these changes to technology cost and performance characteristics.

Financing assumptions have not been changed because this project is intended to have a long-term view through 2020.

4.1 Updating Process

Adjustments were made to key assumptions based on input from the Phase 2B Workgroup, which consists of industry representatives, developers, utilities, and other interested stakeholders. To facilitate discussion, Black & Veatch presented the original Phase 1B estimates which had been developed in 2008 as part of a stakeholder process. Black & Veatch also presented the assumptions developed as part of a similar stakeholder process for the Western Renewable Energy Zones (WREZ) work in 2009. Based on these sources, other industry data, and stakeholder input, consensus was reached on new assumptions to use for the Phase 2B report. This section compares the RETI 1B, WREZ, and RETI 2B numbers for each technology.

4.2 Cost Basis

The cost basis for the assumptions is similar to RETI Phase 1B. All costs were calculated in 2010 dollars on an overnight basis, but with the inclusion of an allowance for interest during construction. In addition, consistent with previous RETI work, it was assumed that the performance and cost of projects would not change over time.

Cost estimates for RETI are meant to be all-inclusive to simulate total generation costs over the life of a project. Capital costs include engineering, procurement and construction cost (EPC) costs plus all owners' costs. The owners' costs include project advisors, development costs, interest during construction, insurance, financing fees, development fees, owner's engineer, independent engineer, construction management, land (if applicable), spare parts, sales taxes, start-up, etc. Operations and maintenance costs include all normal O&M costs (labor, consumables, land lease/royalties, etc.), on-going capital expenditures, property tax, and insurance.

The ranges presented in this section are meant to represent typical project characteristics. Site specific estimates were developed for most projects in RETI. In general, the site-specific estimates fall within the range presented here, although there are some outliers.

4.3 Biomass

Several changes to biomass cost and performance characteristics have been made. As a result of workgroup discussions, biomass plant capital costs have been reduced about 10 percent, and O&M costs have been increased 10 percent. Also, the 30 percent ITC is now available to biomass plants. Previously, the $10/MWh PTC was the primary economic incentive. The performance has been improved by increasing the capacity factor from 80 percent to 85 percent. Table 4-1 shows the new assumptions used for biomass.

Table 4-1. Biomass Assumptions.

	RETI 1B	WREZ	RETI 2B
Performance			
Net Plant Heat Rate (HHV, Btu/kWh)	14,000 to 15,800	14,000 to 16,000	14,000 to 16,000
Capacity Factor (percent)	80	85	85
Economics (2010 $)			
Total Project Cost ($/kW)	4,350 to 5,500	3,500 to 4,500	4,000 to 5,000
Consolidated O&M ($/MWh)	23 to 31	25 to 35	25 to 35
Notes: Combustion-based technology (stoker/fluidized bed), Projects > 15 MW			

4.4 Geothermal

The workgroup agreed to generally adopt the WREZ assumptions for geothermal. The upper end of the capital cost range has been increased to accommodate new smaller out-of-state plants. Also, the cost of generation calculation now reflects the availability of the 30 percent ITC vs. the $21/MWh PTC. The new cost assumptions can be found in Table 4-2.

Table 4-2. Geothermal Assumptions.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	80-90	80-90	80-90
Economics (2010 $)			
Total Project Cost ($/kW)	4,000-6,750 (avg. 5,800)	4,000-8,000 (avg. 6,300)	4,000-8,000 (avg. 6,300)
Consolidated O&M ($/MWh)	31 to 41	27 to 42	27 to 42
Notes: Conventional binary or flash technology, depending on resource			

4.5 Wind

Wind project costs have declined recently due to the global recession and slackening of demand growth relative to new manufacturing additions. For this reason, the cost of wind projects was reduced $100/kW below the RETI Phase 1B range, and up to $200/kW below WREZ assumptions. Also, the cost of generation calculation now reflects the availability of the 30 percent ITC vs. the $21/MWh PTC.

Because some out-of-state resources are better than California, their inclusion has increased the upper end of the capacity factor range in RETI by two percentage points. The resource profiles for out-of-state wind resources are from the WREZ model. They have been adjusted from the original WREZ data set to reflect new capacity factor recommendations developed with Lawrence Berkeley National Lab (LBNL). Their recommendations are based on the review of data from newly operational projects built from 2005-2007. The new capacity factors are shown in Table 4-3. Capacity factors for in-state projects remained unchanged.[4]

[4] Capacity factors were not updated for California because California estimates already reflect performance of "modern" turbines. In California, Black & Veatch identified actual sites, reviewed wind speed data (at 70m), then picked an appropriate IEC class turbine to match the site characteristics. This turbine selection was based on the most common machines that are employed today from Vestas, GE, etc. The performance was calculated using power curves for these "modern" turbines. Black & Veatch adjusted the wind speed data to match the 80-m hub height, adjusted for site air density, and accounted for the Weibull shape factor for the wind resource.
For out-of-state resources in WREZ, Black & Veatch took a simpler approach since specific sites were not identified. NREL 50-m wind power density class rankings were used. There is not a commonly accepted translation between NREL wind class and expected capacity factor. Black & Veatch reviewed operational data at the time and made an estimate of what the relationship was. The issue was that the operational data included all types of projects, many of which were older with lower performance. In fact, as turbine

Table 4-3. New Out-of-state Capacity Factors based on NREL Wind Class at 50 m.

Wind Power Class	Old	New
Class 3	28%	32%
Class 4	31%	36%
Class 5	35%	39%
Class 6	40%	42%
Class 7	42%	46%
Source: Recommendation of LBNL		

The new cost and performance assumptions can be seen in Table 4-4.

Table 4-4. Wind Assumptions.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	25 to 40	32 to 42	CA: 25 to 40 OOS: 32 to 42
Economics (2010 $)			
Total Project Cost ($/kW)	2,250 to 2,700	2,350 to 2,700	2,150 to 2,600
Consolidated O&M ($/MWh)	18 to 25	23	18 to 25
Notes: Conventional, horizontal-axis, 3-blade machine, 80m hub-height			

4.6 Solar

Numerous changes were made for solar technologies. Significant cost reductions in PV have been considered in the update, and new and moved solar projects have had their design and performance assumptions updated. Solar thermal plants have had their performance characteristics updated, and the selection of dry/wet-cooling and storage/no storage has been revisited. The model now also automatically compares the performance and cost of solar thermal, tracking crystalline PV and thin film PV and chooses the best

designs have been improving, towers getting taller, and rotors larger, the capacity factor by wind class has been getting better, as demonstrated in LBNL's analysis.
In summary, Black & Veatch updated the out-of-state resource to match performance of modern turbines. The in-state resource assessment had already taken this into account.

technology for a given site based on the lowest rank cost technology.[5] In this way, the economics for solar CREZs can be reflected in their best light.

The remainder of this section describes the updates for solar thermal and solar PV.

4.6.1 Solar Thermal

Solar thermal performance calculations were redone for the latest analysis. The updated model uses performance calculated with the latest version of NREL's Solar Advisor Model. Previously solar thermal profiles might have exceeded maximum capacity at times as a result of scaling the profiles to the appropriate capacity factors. These profiles have been adjusted to "truncate" production when maximum capacity has been reached, resulting in more accurate profiles. This results in improved solar field performance when energy is not being "dumped", and a more realistic (lower) output when energy is being dumped. Overall, this results in a decrease in capacity factor for plants without storage, and an increased capacity factor for plants with storage.

Solar thermal plants can be either wet- or dry-cooled. In RETI Phase 1B wet cooling was allowed for projects near populated areas where a source of reclaimed water might be available. The wet-cooling policy for solar thermal projects has been revised. Wet-cooling is now only allowed in cases where a plant is already permitted to use water. This has resulted in an increased capital cost and decreased capacity factor for solar thermal plants.

The default storage assumption has also been changed. Although projects with storage have favorable economics in the model, few projects in development have opted to use storage. For this update, it is now assumed that no storage is used unless it has been pre-identified for a specific site. Table 4-5 and Table 4-6 show the updated cost and performance assumptions for solar thermal, with no storage and with six hours of storage respectively.

Parabolic trough is the only solar thermal technology with multiple years of operating data at full commercial scale. It was considered the proxy solar thermal technology for RETI Phase 1B and remains so for the Phase 2B report. Other advanced solar thermal technologies are emerging, such as the solar power tower and solar dish Stirling engine. These technologies are addressed in a sensitivity study in Section 7.

[5] In RETI Phase 1B and 2A parabolic trough solar thermal was used as the proxy for all solar technologies.

Table 4-5. Solar Thermal Assumptions – No Storage.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	22 to 32*	20 to 28	20 to 28
Economics (2010 $)			
Total Project Cost ($/kW)	4,700 to 5,300*	5,350 to 5,550	5,350 to 5,550
Consolidated O&M ($/MWh)	30	30	30

Notes: Dry-cooled Parabolic Trough, no storage
*Ranges include wet cooled projects, which typical have higher CF and lower capital cost

Table 4-6. Solar Thermal Assumptions – 6 hours of storage.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	NA	29 to 39	29 to 39
Economics (2010 $)			
Total Project Cost ($/kW)	NA	7,650 to 7,850	7,650 to 7,850
Consolidated O&M ($/MWh)	NA	22	22

Notes: Dry-cooled Parabolic Trough, with 6 hours of storage. Storage based on oversized field with 200 MW steam turbine output

4.6.2 Solar Photovoltaic

The solar PV lifecycle costs have been adjusted based on new data which suggests that PV costs have dropped substantially since the assumptions used in RETI 1B were formed. Thin film solar PV was previously treated as a sensitivity study, but due to falling costs and the increased prevalence of thin film, it is now being considered as one of the available commercial technologies in addition to tracking crystalline PV. Previously, it was treated as a sensitivity study only. Table 4-7 and Table 4-8 show the updated cost and performance characteristics for tracking crystalline and thin film PV, respectively.

Table 4-7. Solar Photovoltaic, Single-Axis Tracking Crystalline Assumptions.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	23 to 28	26 to 31	23 to 30
Degradation			0.75%/year
Economics (2010 $)			
Total Project Cost ($/kW)	7,040 to 7,150	5,750 to 5,950	4,000 to 5,000
Consolidated O&M ($/MWh)	19 to 23	26	20 to 27
Notes: Large Systems, 20 MW or larger			

Table 4-8. Solar Photovoltaic, Fixed-tilt Thin Film Assumptions.

	RETI 1B	WREZ	RETI 2B
Performance			
Capacity Factor (percent)	18 to 27	22 to 27	20 to 27
Degradation			1%/year
Economics (2010 $)			
Total Project Cost ($/kW)	3,700 to 4,000	4,550 to 4,750	3,600 to 4,000
Consolidated O&M ($/MWh)	13	24	17 to 25
Notes: Large Systems, 20 MW or larger. Thin film was only considered as a sensitivity study in Phase 1B of RETI.			

4.7 Cost of Generation Summary

Figure 4-1 shows the updated ranges of levelized cost of generation for the primary technologies included in RETI. The general estimates for RETI Phase 1B ("RETI 1") and the RETI Phase 2B ("RETI 2") are compared. It is important to note that the levelized cost of generation is only one component of the resource valuation process. The others include transmission cost, energy value, and capacity value (as presented in the Results section of this report). Except for solar thermal, the costs for technologies have generally dropped. The main drivers for the costs changes for each technology are summarized in Table 4-9.

Figure 4-1. Typical Cost of Generation Ranges.

Table 4-9. Summary of the major drivers of technology cost changes.

	Impact	
Technology	**Decrease Costs**	**Increase Costs**
Biomass	• 30% ITC vs. $10 MWh PTC • CF increased from 80% to 85% • 10% reduction in capital cost	• 10% increase in O&M costs
Wind	• 30% ITC vs. $21 MWh PTC • The maximum capacity factor increased by 2% due to OOS wind • Reduction in capital cost of $100/kW	
Geothermal	• 30% ITC vs. $10 MWh PTC	• Upper end of capital cost range increased to accommodate new smaller OOS plants
Solar Thermal		• Increase in capital cost and decreased capacity factor due to assumption of dry cooling
Solar PV	• Substantial drop in capital cost and consideration of thin film as part of base case	

5.0 California CREZ Updates

Several changes and refinements have been made to the CREZs as part of the Phase 2B report. The proposed California Desert Protection Act has impacted several projects, which have been listed here. In addition, several of the CREZs have been refined based on input from the Phase 2B Workgroup and other stakeholders. This section describes these changes by CREZ, and shows the impacts of these changes on overall generating capacity. Any inconsistencies between data sets have been reconciled, and genties, trunklines, and CREZ shapes have also been updated whenever appropriate.

Note that as described in the previous section, multiple solar technologies were possible for any particular site. Solar thermal technology is assumed to have slightly better land use efficiency than solar photovoltaic, and this leads to differences in capacity estimates. For example, a proxy solar thermal project is 200 MW, while a solar PV project is 150 MW for the same area. Unless otherwise indicated, all capacity and generation estimates provided in this report are based on the solar thermal capacity, since this was the convention used in RETI Phase 1B and Phase 2A. In the economic analysis, the most economical solar technology is picked per site, and the economics and associated characteristics represent the chosen technology.

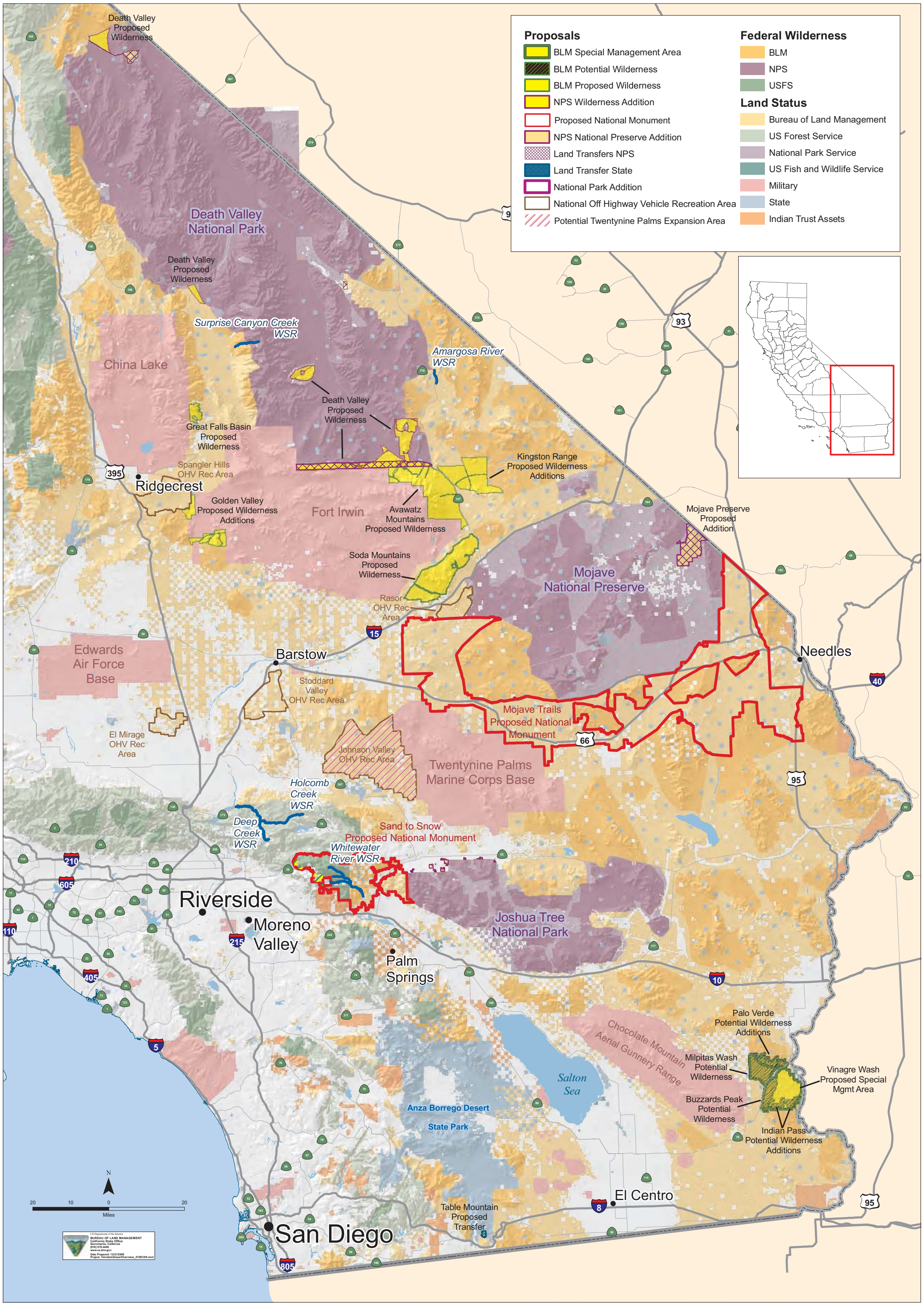
5.1 California Desert Protection Act (CDPA)

In December, 2009, the California Desert Protection Act (CDPA) of 2010 was introduced to the U.S. Congress. Among other items, this bill adds new protected lands in Southern California to the lands designated in the 1994 California Desert Protection Act. Several of the new designated areas conflict with areas identified for renewable energy projects in RETI. Figure 5-1 shows the overview map of the CDPA, including a legend identifying proposals. This map is on the next page and was produced by the BLM

The CDPA proposal was known when the Phase 2A report was prepared in mid 2009; however the specific boundaries were not known. It was determined that once the boundaries were known, that the affected CREZs would be redefined to remove designated areas. Figure 5-2, Figure 5-3, and Figure 5-4 show the areas of interest in the CDPA, and how they affect the CREZs from RETI Phase 2A.

2010 California Desert Protection Act Overview
December 21, 2009

This map prepared at the request of Senator Dianne Feinstein



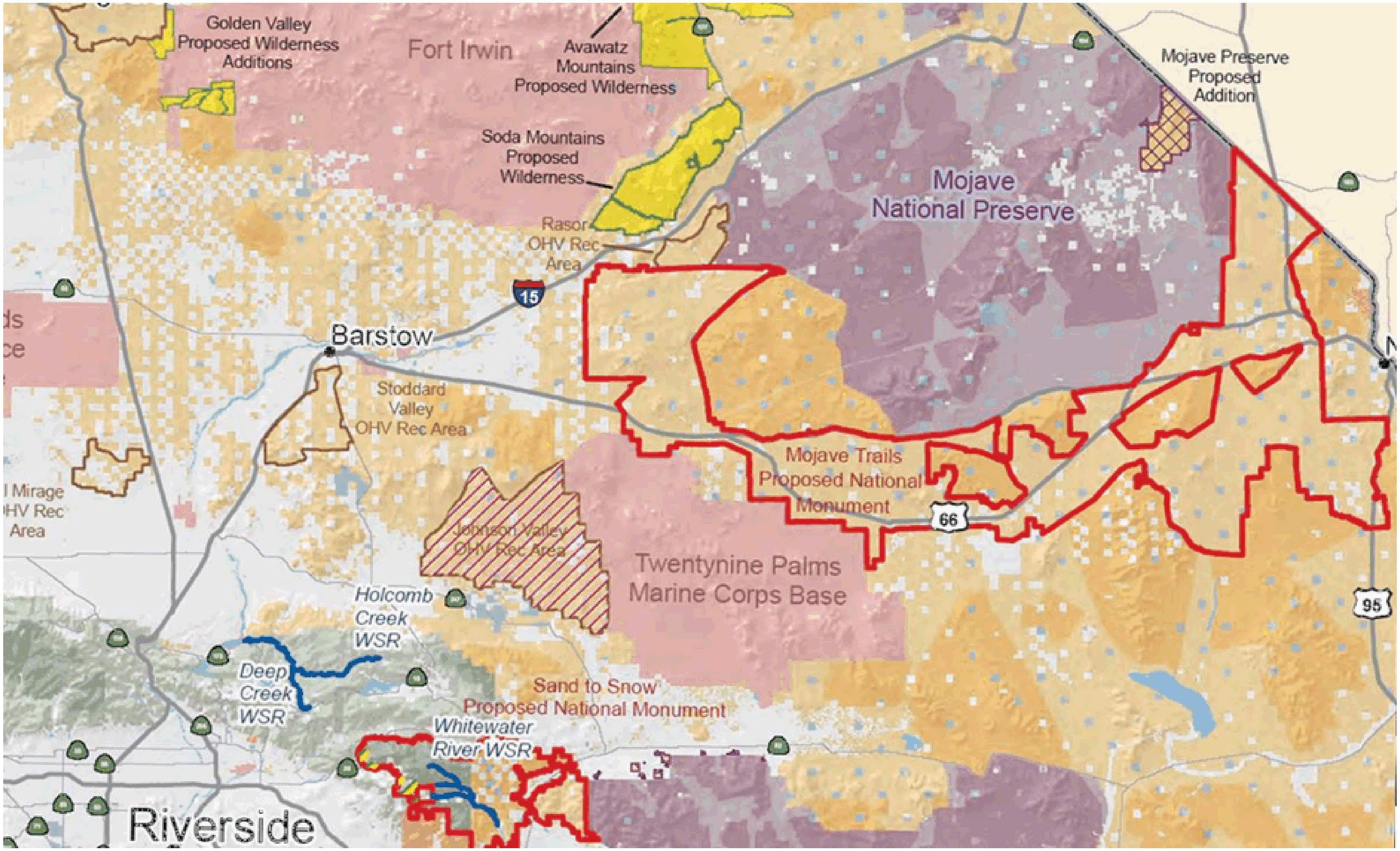


Figure 5-2. Primary Areas Included in the 2010 California Desert Protection Act.[6]

[6] Map Source: http://feinstein.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=14d49cae-7398-4d7e-8693-40ed19b44299

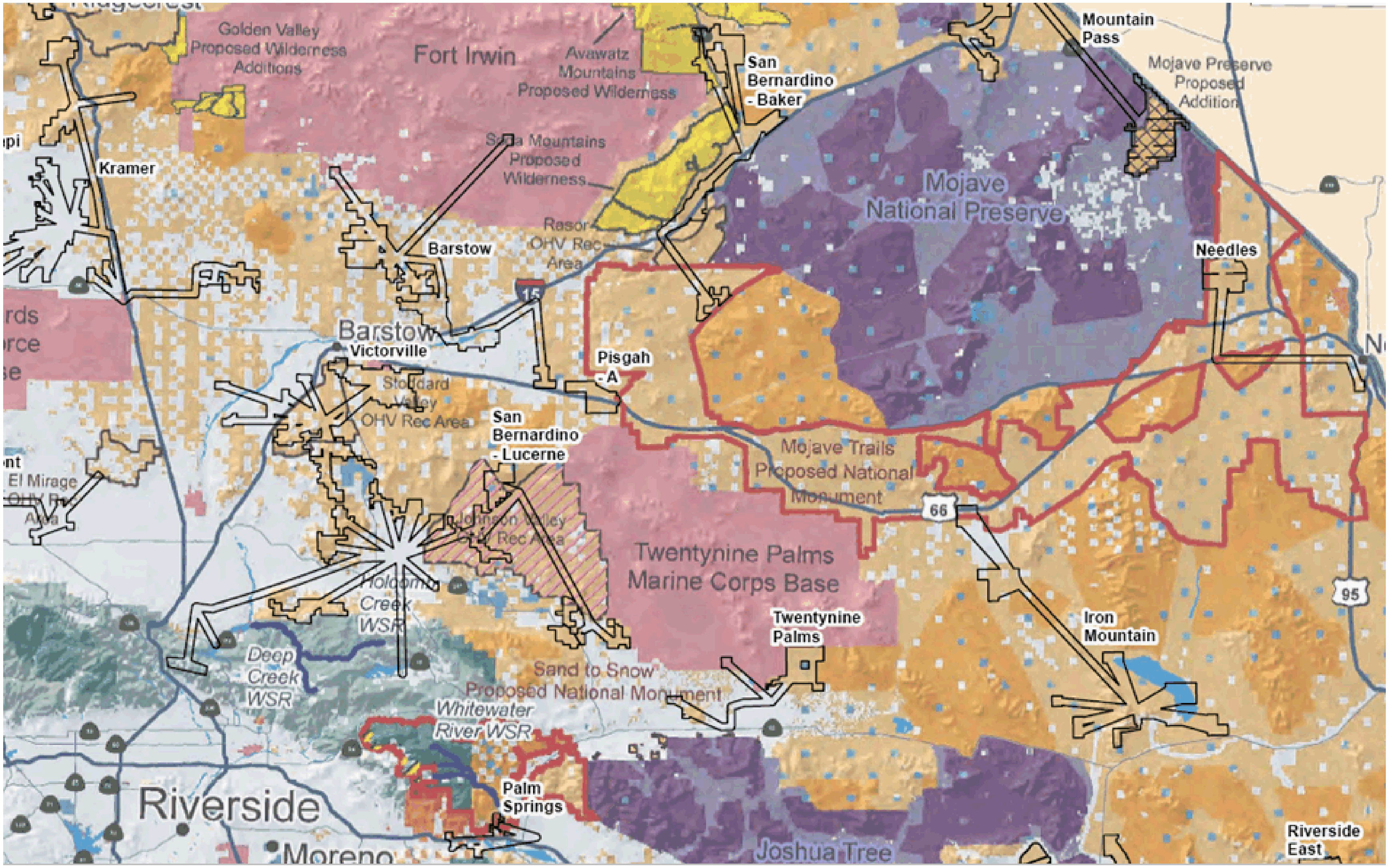


Figure 5-3. CDPA Affected Areas Overlaid with CREZ Boundaries.[7]

[7] CREZ boundaries have since been updated to reflect the CREZ refinements described in this section. For example, the northernmost part of the Iron Mountain CREZ has been moved to the Pisgah CREZ.

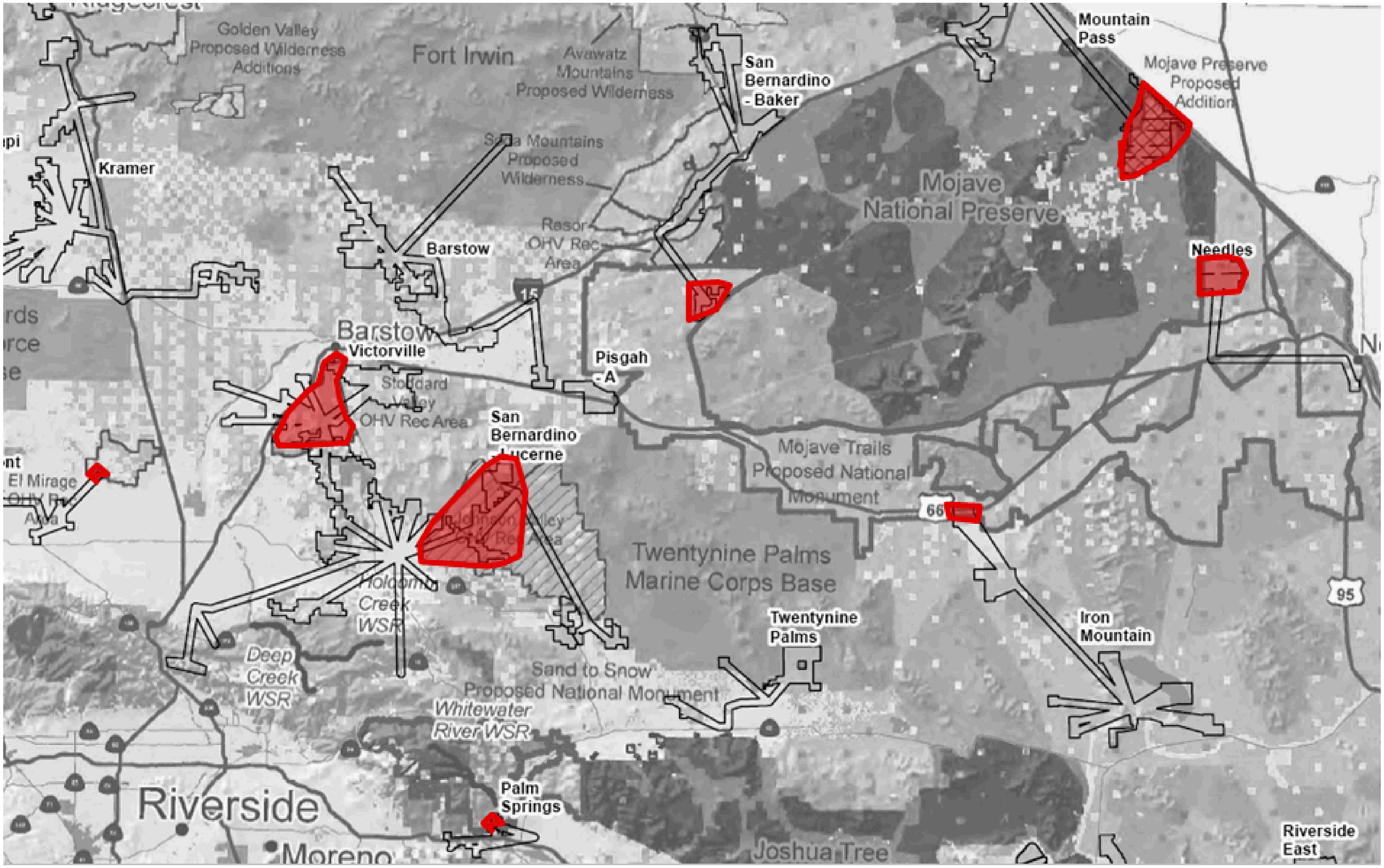


Figure 5-4. General CREZ Areas Affected by the CDPA.

The following CREZs have been affected by the CDPA:

- **Needles –** Two wind projects, totaling 262 MW, were removed due to the proposed Mojave Trails National Monument. The reduction leaves only a single proxy solar project. The Needles CREZ has been removed due to insufficient capacity to justify a CREZ.
- **Mountain Pass –** Five pre-identified wind projects in this CREZ, totaling 699 MW, have been removed due to the expansion of the Mojave National Preserve.
- **San Bernardino Baker –** One pre-identified solar thermal project, totaling 320 MW has been removed due to the proposed Mojave Trails National Monument.
- **Pisgah A –** The northernmost project in the Iron Mountain CREZ, totaling 800 MW, was been moved to Pisgah A. The northern half of this project has been removed due to the proposed Mojave Trails National Monument, leaving the southern half which has been assigned a capacity of 400 MW.
- **San Bernardino Lucerne –** Four solar thermal projects, totaling 800 MW, have been removed due to the Johnson Valley Off-Highway Vehicle (OHV) Recreation Area. Additionally, two wind projects that could have potentially been affected were retained because they are considered potentially compatible with OHV use.
- **Fairmont –** One solar thermal project of 200 MW has been removed due the El Mirage Off-Highway Vehicle Recreation Area.
- **Victorville –** The Stoddard Valley Off-Highway Vehicle Recreation Area in the center of the Victorville CREZ could have potentially affected conflicting wind projects, but these projects have been retained because wind may be potentially compatible with OHV use. A BLM solar project would also have been affected, but the estimated available capacity is not impacted because it has not been explicitly modeled in the Black & Veatch dataset.

5.2 CREZ Refinements

In addition to impacts from the CDPA, several additional CREZ refinements have been made based on working group feedback.

5.2.1 Fairmont

While Fairmont has strong technical potential for wind development, there is a lack of known commercial interest in developing projects in the area. In order to align Black & Veatch's analysis with commercial interest for the area, Black & Veatch reassessed the CREZ. The reassessment focused on the proximity of projects to the Antelope Valley Poppy Reserve, residential encroachment and land ownership parcelization. As a result of the reassessment, Black & Veatch decided to cut four projects, representing 668 MW. These projects are largely adjacent to the Poppy Reserve, but also include one project further south that would be difficult to develop due to parcelization and residential encroachment. Figure 5-5 shows a map of the wind projects removed from the Fairmont CREZ.

5.2.2 Tehachapi

Two projects in the Tehachapi CREZ were very near the Antelope Valley Poppy Reserve and were cut for the same reasons as the projects in the Fairmont CREZ. These two projects represented 412 MW of wind capacity. Figure 5-5 shows a map of the wind projects removed from the Tehachapi CREZ.

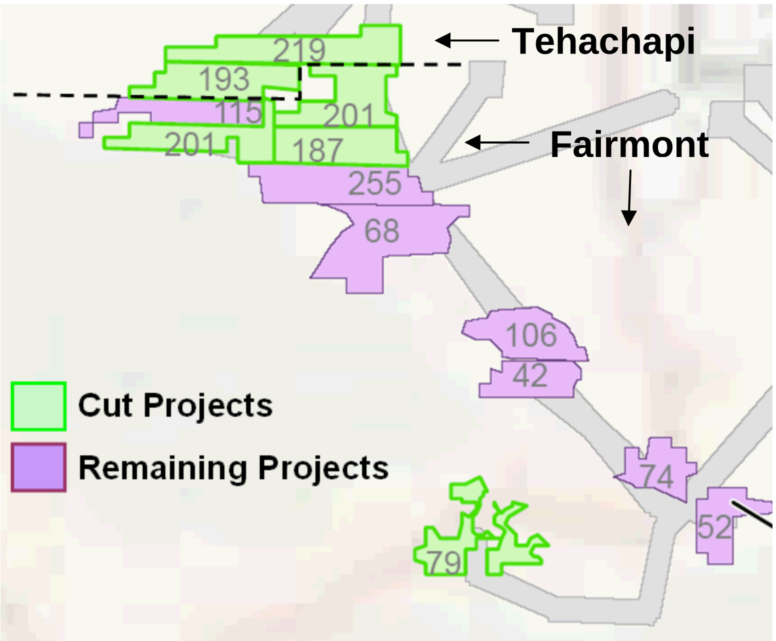


Figure 5-5. Wind Projects Removed from the Fairmont and Tehachapi CREZs.

5.2.3 Palm Springs

Even though the Palm Springs CREZ already includes a large amount of existing wind capacity, over 700 MW of additional capacity was identified in RETI Phase 1. Stakeholder feedback had suggested that about 300 MW of additional wind is likely to be developed on the remaining land due to urban encroachment and significant local siting constraints. These factors were not considered in RETI Phase 1. After further review, four projects were cut from the Palm Springs CREZ. The projects were cut due to county setback requirements from two highways in the area, and agreements with two organizations in the area for a moratorium on wind development. As a result, the CREZ was cut from 769 MW to 332 MW. Figure 5-6 shows a map of the projects removed from this CREZ.

The boundaries of the remaining wind projects should not be considered precise; all projects in this area have significant siting constraints that are beyond the high-level review that RETI performs. Nevertheless, Black & Veatch feels the overall capacity estimate for Palm Springs is a reasonable estimate of incremental potential on undeveloped lands and perhaps some repowering of existing projects.

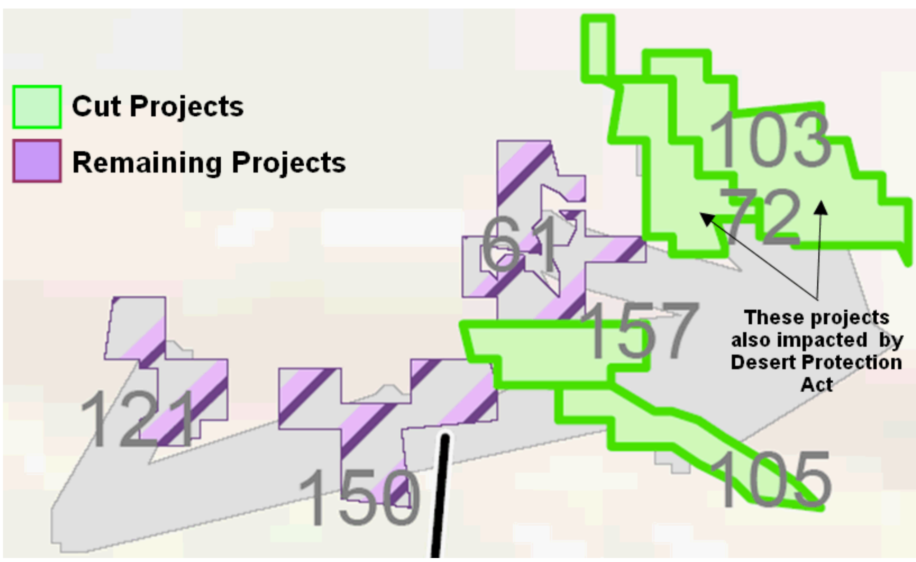


Figure 5-6. Wind Projects Removed from the Palm Springs CREZ.

5.2.4 Westlands Water District

A new solar CREZ has been identified on the Westlands Water District property in the Central Valley. This CREZ is in a moderate solar area, but more importantly it consists of disturbed agricultural land contaminated with selenium that has few alternative uses.[8]

The CREZ is also adjacent to existing transmission and the Gates substation. About 30,000 acres are available, and this CREZ has the potential to be up to 5,000 MW. The location of the new CREZ can be seen in Figure 5-7.

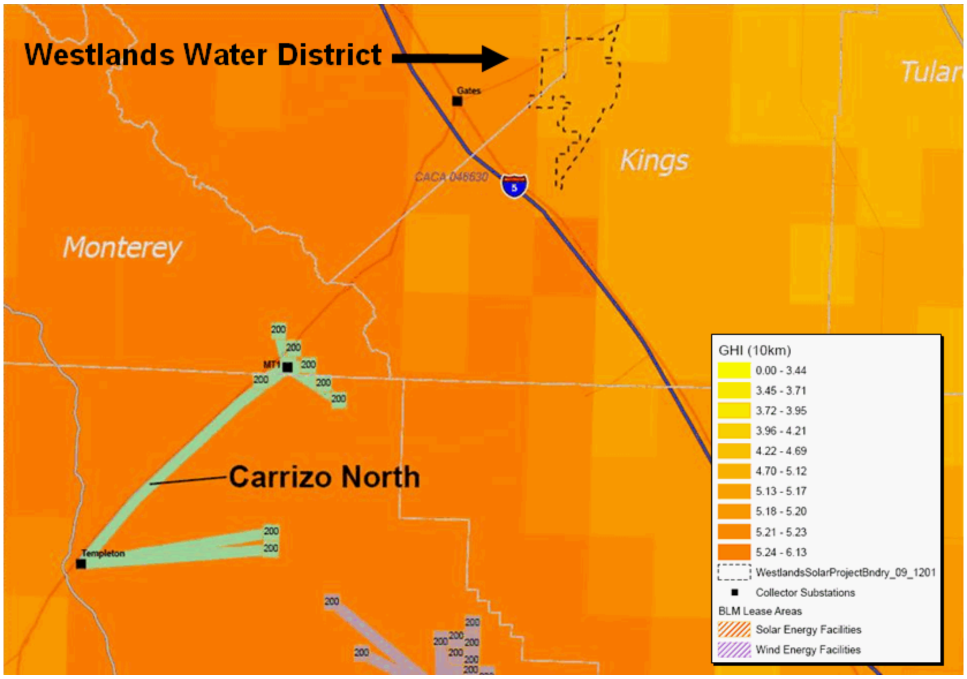


Figure 5-7. Location of the New Westlands Water District CREZ.

5.2.5 Owens Valley

Based on recent commercial interest in the area, Inyo County has requested consideration of additional lands for renewable energy development. Black & Veatch had originally screened many solar sites in Inyo County due to lack of commercial interest and relatively poor economics compared to solar CREZ further south. Black & Veatch has added some sites back to the analysis that were previously cut. The most economic projects adjacent to the existing CREZ (and existing transmission) were added. The additions increase the size of the Owens Valley CREZ from 1,400 MW to 5,000 MW. These new project sites are primarily located on or near Owens Dry Lake. Due to water diversions started decades ago, LADWP dried up the lake and is now responsible

[8] The Westlands CREZ scored well in all environmental scoring categories except in one category, which is the foot print criteria. That relatively poorer score is because Westlands does not have the same relative solar resource as the desert, so it takes up a much larger relative footprint than a project with the same energy output. .

for extensive dust mitigation activities on the lake. LADWP has announced a solar pilot project at the lake to test the ability of solar to control dust emissions. A map of the projects added can be seen in Figure 5-8.

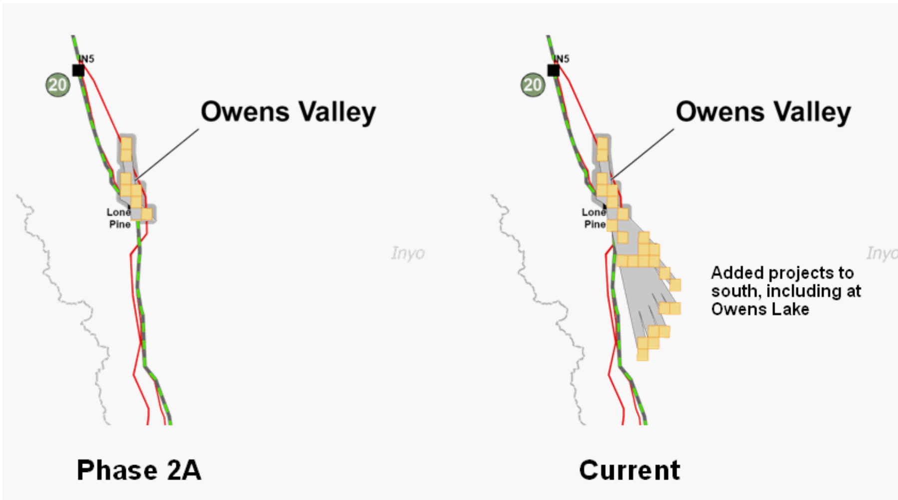


Figure 5-8. Solar Projects Added to the Owens Valley CREZ.

5.2.6 Additional Minor Changes

Various other minor changes were made to CREZs, as described below:

- **Carrizo South –** the solar capacity was changed from 3,877 MW in Phase 2A to 3,000 MW. RETI Phase 1B had 3000 MW, and there appears to have been a mistake when the capacity was increased in Phase 2A.
- **Cuyama –** the solar capacity was changed from 800 MW in Phase 2A to 400 MW. RETI Phase 1B had 400 MW, and there appears to have been a mistake when the capacity was increased in Phase 2A.
- **Imperial East** – a 49 MW wind project was found to have significant overlap with an environmental blackout area and was removed.
- **Iron Mountain –** a small discrepancy (50 MW) was fixed due to the capacity assumption for the Trilobite solar project, which has been subsequently moved to Pisgah.
- **Round Mountain B –** a 55 MW biomass project was dropped since there are already competing biomass plants in Shasta County.
- **San Diego North Central** – an 80 MW wind project was found to have significant with Anza Borrego Desert State Park and was removed.

5.3 CREZ Capacity Estimates

A summary of all the CREZ changes from Phase 2A to Phase 2B is provided in Table 5-1. While there were numerous CREZ reductions, the overall California CREZ capacity increased by about 3,000 MW compared to Phase 2A. Table 5-2 shows the capacity estimates for each CREZ in the Phase 2B report.

Table 5-1. Summary of CREZ Capacity Changes from Phase 2A to Phase 2B.

	Capacity (MW)					
CREZ	**Biomass**	**Geothermal**	**Solar**	**Wind**	**Total**	**Notes**
Barstow	-	-	-	-	-	No changes
Carrizo North	-	-	-	-	-	No changes
Carrizo South	-	-	(877)	-	(877)	Revised solar to 1B values, which were correct.
Cuyama	-	-	(400)	-	(400)	Revised solar to 1B values, which were correct.
Fairmont	-	-	(200)	(668)	(868)	Cut wind projects due to CREZ refinement. Solar project due th CA DPA
Imperial East	-	-	-	(49)	(49)	Dropped one wind project due to overlap with black-out area
Imperial North-A	-	-	-	-	-	No changes
Imperial North-B	-	-	-	-	-	No changes
Imperial South	-	-	-	-	-	No changes
Inyokern	-	-	-	-	-	No changes
Iron Mountain	-	-	(50)	-	(50)	Small discrepancy due to Trilobite capacity assumption (moved in Phase 2A)
Kramer	-	-	-	-	-	No changes
Lassen North	-	-	-	-	-	No changes
Lassen South	-	-	-	-	-	No changes
Mountain Pass	-	-	-	(700)	(700)	Cut wind projects due the CA DPA
Needles	-	-	(200)	(261)		Cut wind projects due the CA DPA; eliminated CREZ as below 250 MW.
Owens Valley	-	-	3,600	-	3,600	Added 3600 MW of solar
Palm Springs	-	-	-	(437)	(437)	Cut wind projects due to CREZ refinement.
Pisgah-A	-	-	(350)	-	(350)	Cut half of Trilobite project due the CA DPA
Riverside East	-	-	-	-	-	No changes
Round Mountain-A	-	-	-	-	-	No changes
Round Mountain-B	(55)	-	-	(0)	(55)	Biomass project dropped since resource already in use in Shasta County
San Bernardino - Baker	-	-	(320)	-	(320)	Cut solar projects due to CA DPA
San Bernardino - Lucerne	-	-	(800)	-	(800)	Cut solar projects due to CA DPA
San Diego North Central	-	-	-	(80)	(80)	Dropped one wind project due to overlap with black-out area
San Diego South	-	-	-	-	-	No changes
Santa Barbara	-	-	-	-	-	No changes
Solano	-	-	-	-	-	No changes
Tehachapi	-	-	-	(412)	(412)	Cut wind projects due to CREZ refinement.
Twentynine Palms	-	-	-	-	-	No changes
Victorville	-	-	-	-	-	No changes
Westlands	-	-	5,000	-	5,000	Added 5000 MW of solar
Total	**(55)**	**-**	**5,403**	**(2,608)**	**3,202**	

Table 5-2. Phase 2B CREZ Capacity Estimates.

	Capacity, MW				
CREZ	**Biomass**	**Geothermal**	**Solar Thermal**	**Wind**	**Total**
Barstow			1,400	936	2,336
Carrizo North			1,600		1,600
Carrizo South			3,000		3,000
Cuyama			400		400
Fairmont	138		1,800	712	2,650
Imperial East			1,500	74	1,574
Imperial North-A		1,370			1,370
Imperial North-B	30		1,800		1,830
Imperial South	36	64	3,570	45	3,715
Inyokern			2,145	287	2,432
Iron Mountain			4,800	62	4,862
Kramer		24	6,185	203	6,412
Lassen North				1,467	1,467
Lassen South				410	410
Mountain Pass			780	178	958
Owens Valley			5,000		5,000
Palm Springs				333	333
Pisgah			2,200		2,200
Riverside East			10,550		10,550
Round Mountain-A		384			384
Round Mountain-B				132	132
San Bernardino - Baker			3,350		3,350
San Bernardino - Lucerne	91		1,540	599	2,230
San Diego North Central				200	200
San Diego South				678	678
Santa Barbara				433	433
Solano				894	894
Tehachapi	37		7,195	3,193	10,425
Twentynine Palms			1,805		1,805
Victorville			1,200	436	1,636
Westlands			5,000		5,000
Grand Total	**332**	**1,842**	**66,820**	**11,273**	**80,267**

6.0 Out-of-state Additions and Improvements

Several additions and improvements have been made to the out-of-state resource analyses to address previous concerns and also to take advantage of better resource information made available in other recent studies. This section describes all of the changes made to the out-of-state (OOS) resources, including the new out-of-state transmission cost approach. Unless otherwise stated in this section, the same assumptions used throughout RETI were also used for out-of-state resources, including financing assumptions, and the methodologies used for calculating generation cost, integration cost, energy value, and capacity value.

The most significant new input to the out-of-state resource assessment is information from the recent Western Renewable Energy Zones (WREZ) study. WREZ included a high-level WECC-wide analysis of renewables and transmission costs from renewable energy zones to load centers. The renewable resources in these zones, also known as Qualifying Resource Areas (QRAs), provide a potential new source of out-of-state resource and cost data.

6.1 Description of WREZ QRAs

Similar to CREZs in California, QRAs represent conceptual analytical areas created to estimate the resources available within an area for modeling purposes. The QRAs are generally organized by region. Fifty-three QRAs were identified across the WREZ study area, with nearly 200,000 MW of renewable energy resources theoretically capable of generating over 560 terawatt hours (TWh) of energy per year. QRA boundaries were developed to quantify the resources in an area for a screening level analysis. They do not indicate actual planned transmission service to these areas or the location of planned transmission interconnection points. Furthermore, it is important to note that renewable development is not precluded in other areas that do not fall inside QRA boundaries.

While not a resource assessment in the strictest sense, the WREZ QRA analysis demonstrates how renewable energy resources are distributed across the WECC in addition to creating data for the transmission modeling. The analysis also provides some data on general costs of generation for different renewable energy technologies in different areas across the WECC.

Figure 6-1 shows a map of the general QRA names and locations. They are represented by hubs of various sizes, based on the total resource capacity within the QRA.

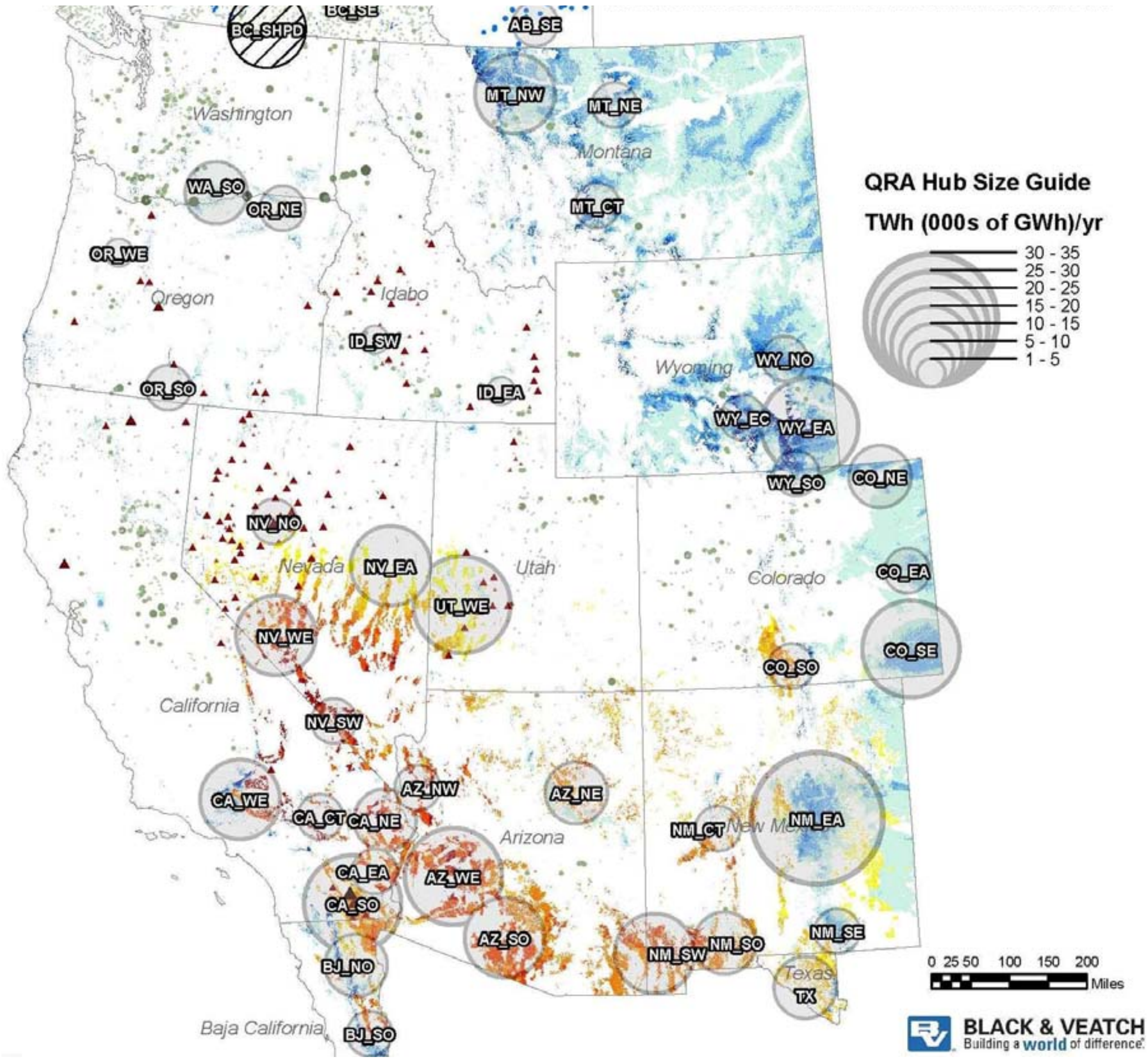


Figure 6-1. Map of WREZ QRA Hubs.

6.2 Resource Screening

In many cases, the data from the WREZ study offers an improvement over the previous RETI data for out-of-state areas. Perhaps more importantly, it represents a data set that is consistent across WECC and that was developed in a stakeholder process.

The WREZ resource database could contribute to the RETI model in two ways: (1) improved resource data for identified existing areas covered in RETI and (2) additional resource data for new areas. In order to determine where to use WREZ resources, supply curves were made of all WREZ resources, with costs based on delivery to California and using assumptions compatible with RETI. Based on the results, the following resources were added to the RETI out-of-state resources:

- Solar PV – Nevada and Arizona
- Biomass – Nevada, Arizona, Idaho and Utah
- Wind – Arizona, Wyoming, Idaho, and New Mexico
- Geothermal – Idaho and Utah

For some out-of-state resources already included previously in RETI, newer, higher quality results were available from the WREZ project. The following areas adopted new data from WREZ:

- Solar Thermal – Nevada and Arizona
- Biomass – British Columbia
- Wind – Oregon, Washington, and British Columbia
- Geothermal – British Columbia and Oregon

All of the resources in Alberta, Montana and Colorado were screened out of the analysis since there appear to be lower cost resource options in adjacent states.

The previous analyses for Baja California wind and Nevada geothermal were also replaced, but rather than using results from WREZ they were completely reassessed. These will be covered in more detail in sections 6.2 and 6.3. Finally, wind in Nevada was assessed by combining the WREZ Nevada wind assessment and the RETI Phase 1B assessment for southern Nevada. This is described further below.

It should be noted that throughout the out-of-state resource analysis, the economics for all of the resources within a zone were averaged to develop a single rank cost ($/MWh) representing the relative economic competitiveness of the entire zone. This simplifies the comparison, but may prevent some of the better resources from being higher ranked. This issue may be addressed in the final Phase 2B report.

Figure 6-2 shows a map of the resources in each region that have been included in the updated RETI model. The QRAs are named based on the dominant location of the resources within the QRA, starting with the state abbreviation and followed by the regional abbreviation - NO for north, CT for central, etc. For example, BJ_SO is the name for the QRA located in Southern Baja. However, all of the resources within a QRA may not be located in that particular state or region.

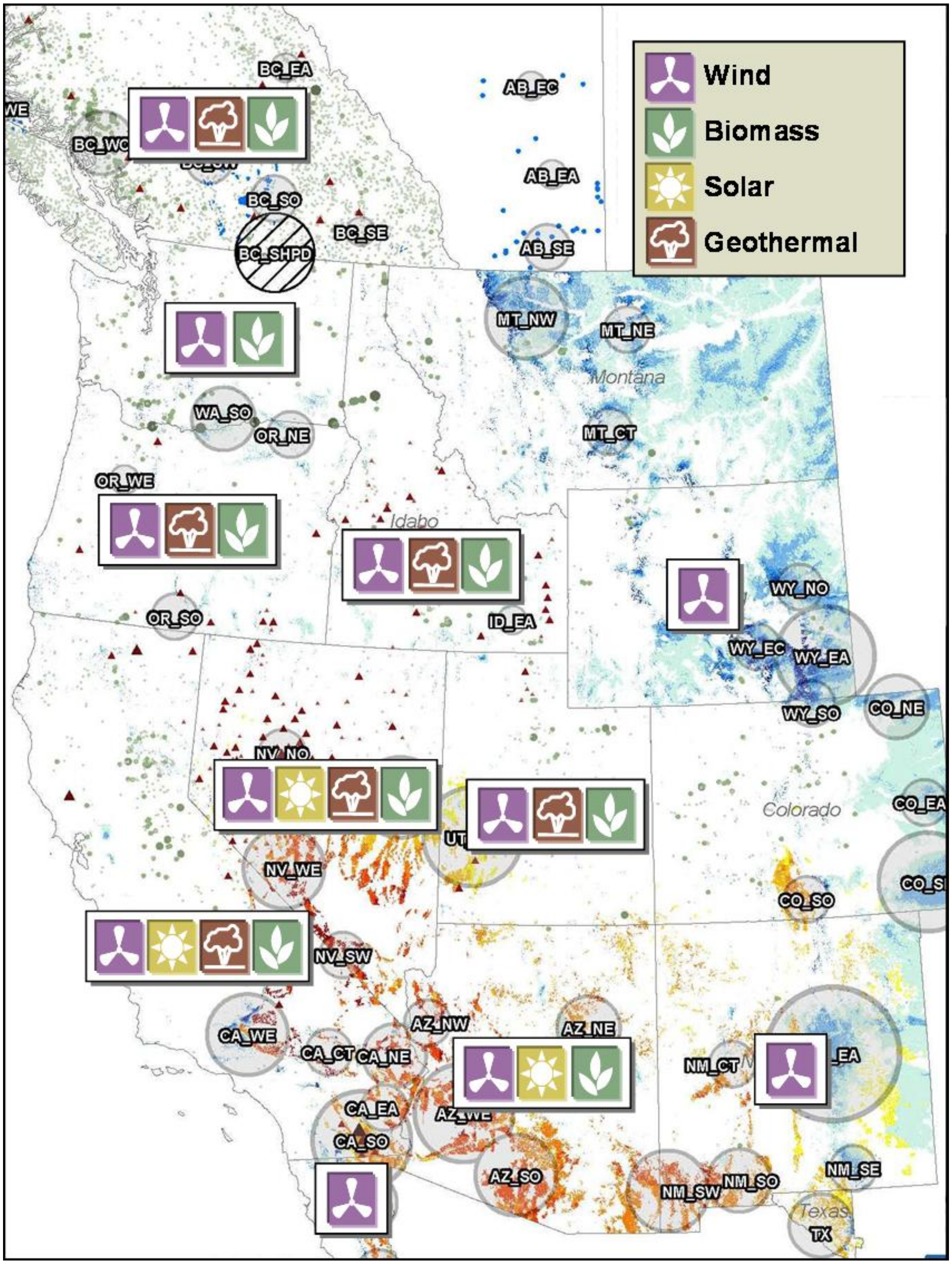


Figure 6-2. Resources Included in RETI Phase 2A.

6.3 Nevada Geothermal and Wind

Black & Veatch updated the wind and geothermal assessments for RETI Phase 2A. For geothermal, Black & Veatch relied on work performed by GeothermEx.

GeothermEx reviewed the previous RETI and WREZ assessments and updated their database of potential project developments. GeothermEx considered new information, such as the 2009 BLM lease auction results. Based on this assessment, GeothermEx increased its estimate of Nevada geothermal resources from 1450 MW (net) in RETI Phase 1B to 1587 MW (net) for the Phase 2B report. Following the GeothermEx review, Black & Veatch removed any sites already under contract to NV Energy, since these are not directly available to California. The final total for Phase 2B is 1459 MW (net).

For Wind, Black & Veatch combined the following data sources:

- 198 MW - Western Nevada Wind from WREZ
- 233 MW - Southwestern Nevada Wind from WREZ
- 1,322 MW - Southern Nevada from original RETI Phase 1 analysis
    - Removed one project to avoid double counting with WREZ NV_SW QRA (windnvaz_33 – 153 MW)

The updated Nevada wind assessment totals 1754 MW for RETI Phase 2A.

6.4 Baja Wind Energy Assessment

In RETI Phase 1B, a cursory preliminary assessment of the wind resource in Baja California Norte (Baja) was performed. About 25,000 MW of technical potential was identified before consideration for developmental constraints. About 5,000 MW of developable wind was identified based on the CAISO queue, 2,368 MW of which was considered “cost competitive” in the Phase 1B economic analysis. Because of the cursory nature of the Phase 1B resource assessment and the potential competitiveness of this resource, it was determined that a more detailed assessment should be performed.

6.4.1 Approach

The approach taken for project assessment in Baja was detailed and is similar to the project assessment approach used for California wind projects in RETI Phase 1B. The wind resource for the new assessment was identified using the NREL wind power density map circa 2004. This map was developed for NREL by AWS TrueWind using their Mesomap system. The proper exclusions were removed from available areas, including national parks and protected lands, population centers, and rugged terrain. Project boundaries were then drawn around the remaining resource. These comprised two major types of projects: projects following a ridgeline, and projects composed of multiple rows of turbines. The latter type of project was further characterized as being on flat land, rolling hills, rough terrain, or very rough terrain. Finally, the projects characteristics were determined, including capacity (MW), annual energy production (GWh), installed capital cost ($/kW), and levelized cost of energy ($/MWh).

For the transmission analysis, projects were either collected at the Imperial Valley South substation, or SDGE's proposed ECO substation. Each substation had a conceptual trunkline created that extended across the border to collect wind from Baja. The conceptual trunkline from the Imperial Valley South reached the projects in northeastern Baja. The conceptual trunkline for ECO was longer and ran approximately down the center of the state of Baja California Norte, reaching projects to the west and to the south. The chosen collector substation for a project was based on the distance between the project and the nearest conceptual trunkline. Gen-tie and trunkline distances were individually calculated for these projects, unlike the other out-of-state projects in this update. This analysis was done solely for the purpose of estimating relative cost, and is not meant to identify any preference for electrical network design or environmental siting.

6.4.2 Results

The new assessment of Baja wind resulted in identification of 33,220 MW of technical potential. Of this, Black & Veatch has counted 25 percent as being developable in the near-term. This resulted in 89 projects totaling 8,305 MW being included in the final analysis, as shown in Figure 6-3. The resource is split into two zones: BJ_NO in the north, and BJ_SO in the south. The overall average capacity factor of these projects was 36 percent, and they had an average capital cost of $2,446/kW and an average gen-tie cost of about $100/kW. While the performance of the Baja wind projects is good, the expected capital costs are higher due to more rugged terrain and the lack of adequate existing infrastructure (roads and transmission) in many parts of the region.

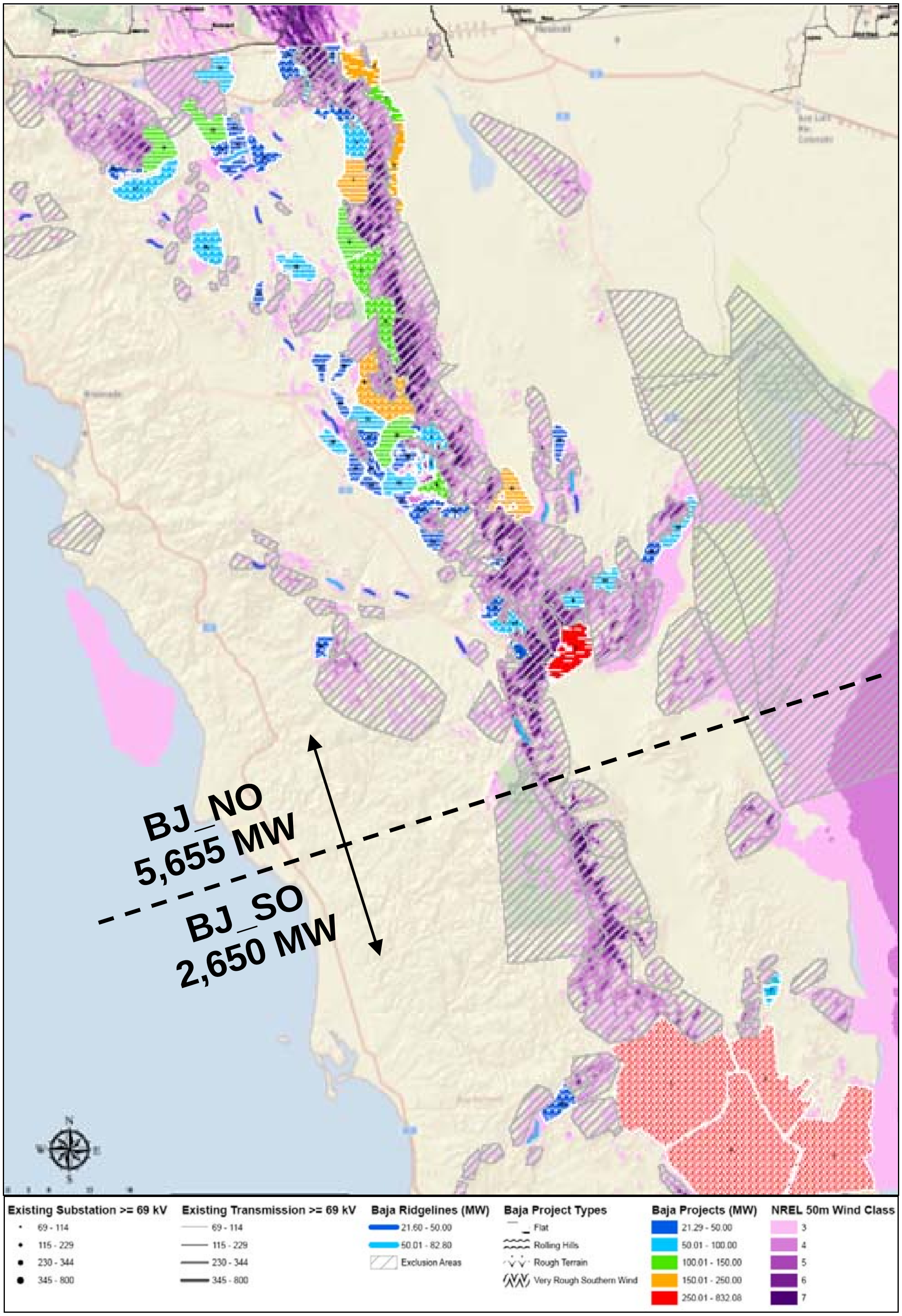


Figure 6-3. Overview of Baja Wind Projects (for Detailed Map see RETI Website).

6.5 Transmission Costs

A new approach to determining transmission costs also needed to be developed for OOS resources. Transmission costs were split between an in-state component and an OOS component. The in-state costs were calculated using the shift factors developed for California resources for RETI Phase 2A. The shift factor approach was not readily adaptable outside the state, so a new approach was developed and new estimates were made. This section describes the assumptions adopted for both in-state and out-of-state transmission, including a detailed explanation of transmission line utilization.

6.5.1 In-state Transmission

The in-state costs were calculated using the shift factors developed for California resources for RETI Phase 2A. The following characteristics have been adopted for the transmission costs of in-state resources:

- Assign OOS resources to a California “gateway” CREZ/substation
- Include all costs for 2A Collector Lines; allocation based on 2A shift factors
- Include 50 percent of the 2A Foundation and Delivery Line costs; allocation based on the 2A shift factors. 50 percent was arbitrarily chosen since it is recognized that not all of the costs for these lines are due to new renewables development.
- Use costs from Phase 2A, annualized with 10 percent fixed charge rate and spread over the energy deliveries on a per MWh basis
- California transmission losses were estimated at 5 percent for all projects regardless of location

Table 6-1 lists the in-state transmission costs determined for each CREZ. The in-state transmission costs do not represent actual costs from the California ISO or reflect the results that would be found in more specific studies. The transmission costs used are for overall transmission planning and the assumptions have been simplified. The ultimate actual design will be quite different, and these costs should only be used relative to each other.

Table 6-1. California In-state Transmission Costs.

CREZ Name	California pro rata Transmission Cost ($Million)	California pro rata Transmission Cost Adder ($/MWh)
Barstow	11.97	$11.08
Carrizo North	7.40	$12.04
Carrizo South	13.88	$11.83
Cuyama	1.85	$11.46
Fairmont	10.42	$7.39
Imperial East	14.01	$20.36
Imperial North-A	18.50	$9.10
Imperial North-B	24.71	$30.93
Imperial South	50.64	$30.66
Inyokern	19.98	$17.75
Iron Mountain	85.96	$41.47
Kramer	33.66	$11.30
Lassen North	16.12	$22.26
Lassen South	4.51	$21.30
Mountain Pass	6.55	$15.39
Needles	0.00	$0.00
Owens Valley	73.29	$34.16
Palm Springs	2.58	$12.21
Pisgah	13.19	$13.91
Riverside East	86.93	$19.16
Round Mountain-A	4.06	$7.88
Round Mountain-B	1.45	$21.23
San Bernardino - Baker	24.65	$17.32
San Bernardino - Lucerne	12.66	$11.11
San Diego North Central	1.86	$18.44
San Diego South	7.89	$21.41
Santa Barbara	2.00	$8.87
Solano	6.08	$11.09
Tehachapi	63.57	$12.41
Twentynine Palms	10.24	$12.84
Victorville	6.85	$8.72
Westlands	23.14	$13.81

6.5.2 Out-of-state Transmission Assumptions

For OOS transmission, RETI used assumptions developed for the WREZ project. As part of the stakeholder process for WREZ, the WREZ Transmission Characteristics Working Group agreed on adopting the following basis for transmission cost assumptions:

- All incremental transmission (that is no existing transmission capacity is used)[9]
- 500 kV single circuit ac lines were used (see Table 6-2)
- The import path was determined based on lowest cost or shortest path as determined by the WREZ Transmission model (see Figure 6-4)
- The lines would be financed with a mix of federal and private financing (see Table 6-3)
- Resources would be delivered to California through "gateway CREZs" (e.g., Mountain Pass) (see section 6.4.3)
- Line utilization for different clusters of resources varied, and was determined by region-specific factors (see section 6.4.4)
- Transmission losses were determined by line distance from the source zone to the California gateway CREZ

Table 6-2. Assumptions Used for a 500 kV Single Circuit Line.

Nominal Capacity (MW)	1,500
Capital Cost ($/mile)	1,800,000
Substation Costs ($)	50,000,000 each
ROW Width (ft)	175
ROW costs per acre ($)	10,700

[9] There is some existing transmission capacity available; however, it is difficult to estimate exactly how much and at what cost for this type of study. In addition, there are currently limits to the amount of variable generation that can be scheduled across interites (e.g., transfer of intermittent wind from BPA to CAISO). These may be resolved in the future.

Table 6-3. Transmission Economic Assumptions, 50:50 Federal/Private.	
Economic Life	40 years
Debt Percentage	50%
Debt Term	30 years
Interest Rate	6%
Equity Cost	13%
Tax Life	15%
Discount Rate	7.625%
Tax Rate	40
Allowance for Funds Used During Construction	7.5% of capital cost
Annual Operation and Maintenance Costs	3% of initial cost

This approach represents a “default” set of assumptions for new transmission development. These assumptions were agreed to by the Phase 2B Workgroup for the sake of consistency, even though it is recognized that there may be opportunities to deliver renewable energy to California at lower cost.[10] The sensitivity of the results to the OOS transmission cost assumptions is explored in Section 7.

[10] Methods to lower transmission cost include: use of existing transmission, better financing, shaping and firming resources, use of more cost effective transmission technologies (e.g., HVDC).

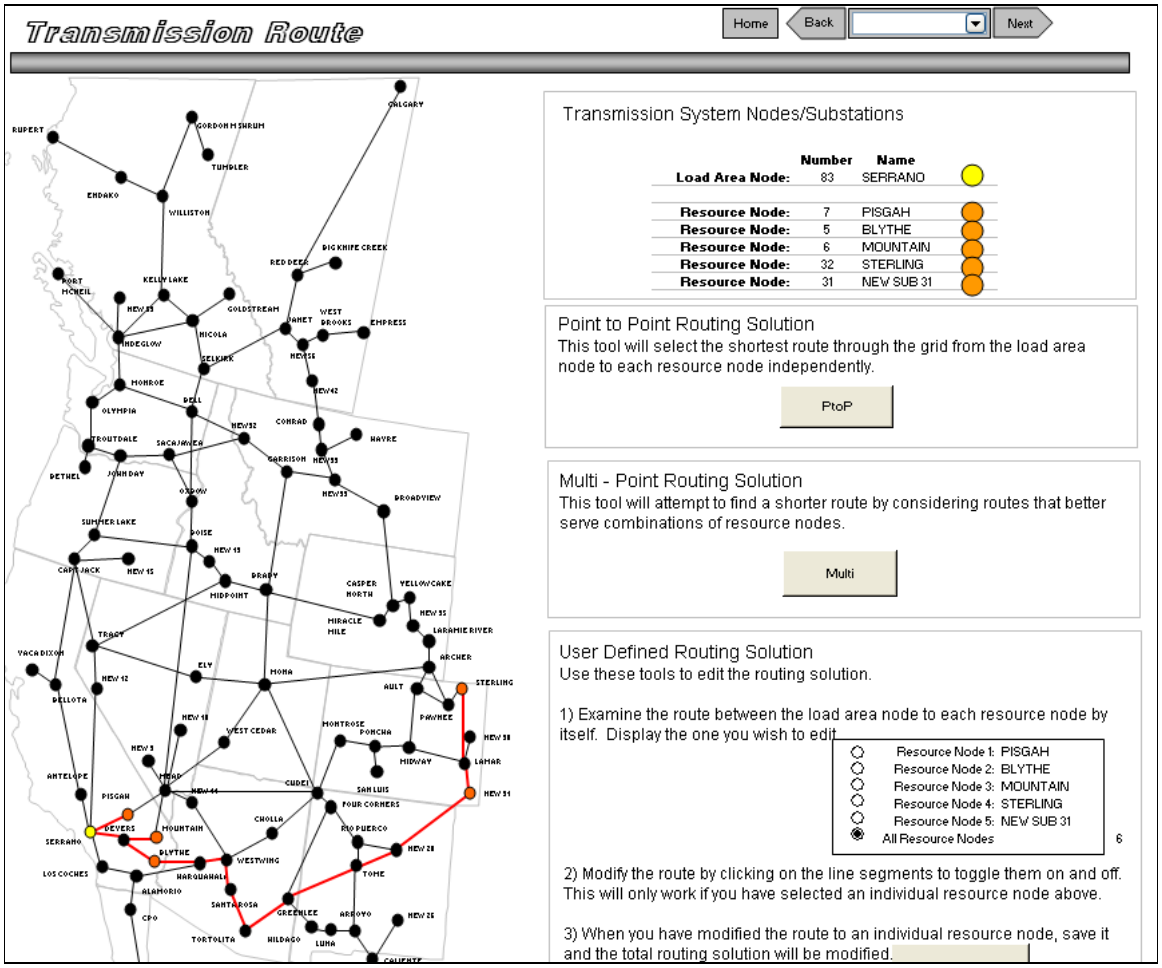


Figure 6-4. Screenshot from WREZ Transmission Model.

6.5.3 California Delivery Gateway Substations

The cost of transmission for out of state resources did not include the cost of transmission within California. The transmission line distances were therefore based on delivery from the OOS resource hub interconnection point to five different "gateway" CREZs within California. Once within California, the Phase 2A shift factors were also then used to assign in-state transmission costs from the gateway CREZs. Table 6-4 lists the gateway CREZs and the corresponding substations used for calculating transmission distance. Figure 6-5 shows a map matching resource areas and gateway CREZs.

It is important to note that the designation of the gateway CREZs is not meant to indicate preference for any particular delivery path. The gateway CREZs are strictly used for economic calculations. The gateway CREZs were automatically identified by the WREZ model since they minimized the OOS component of the transmission cost. There are multiple transmission possibilities on existing and new lines. For example, for the purpose of estimating cost for new transmission, Nevada geothermal was assumed to be delivered to the Owens Valley CREZ, which has the shortest path based on the WREZ model. However, it could also be delivered to northern California (Round Mountain) at potentially lower cost, especially if some existing transmission can be utilized. Similarly, resources from New Mexico may get delivered through southern Nevada to Mountain Pass rather than through Riverside East as indicated in Figure 6-5.

Table 6-4. Out-of-state Resource Gateway CREZs and Corresponding Substations.

Gateway CREZ	Delivery Substation
Round Mountain	Round Mountain
Owens Valley	Lone Pine
Mountain Pass	Mountain Pass A & Mountain Pass B
Riverside East	Midpoint
Imperial Valley / San Diego South	Imperial Valley South, ECO
Note: Gateway CREZs designated for economic calculations only and do not represent a preferred delivery path or delivery point of OOS resources.	

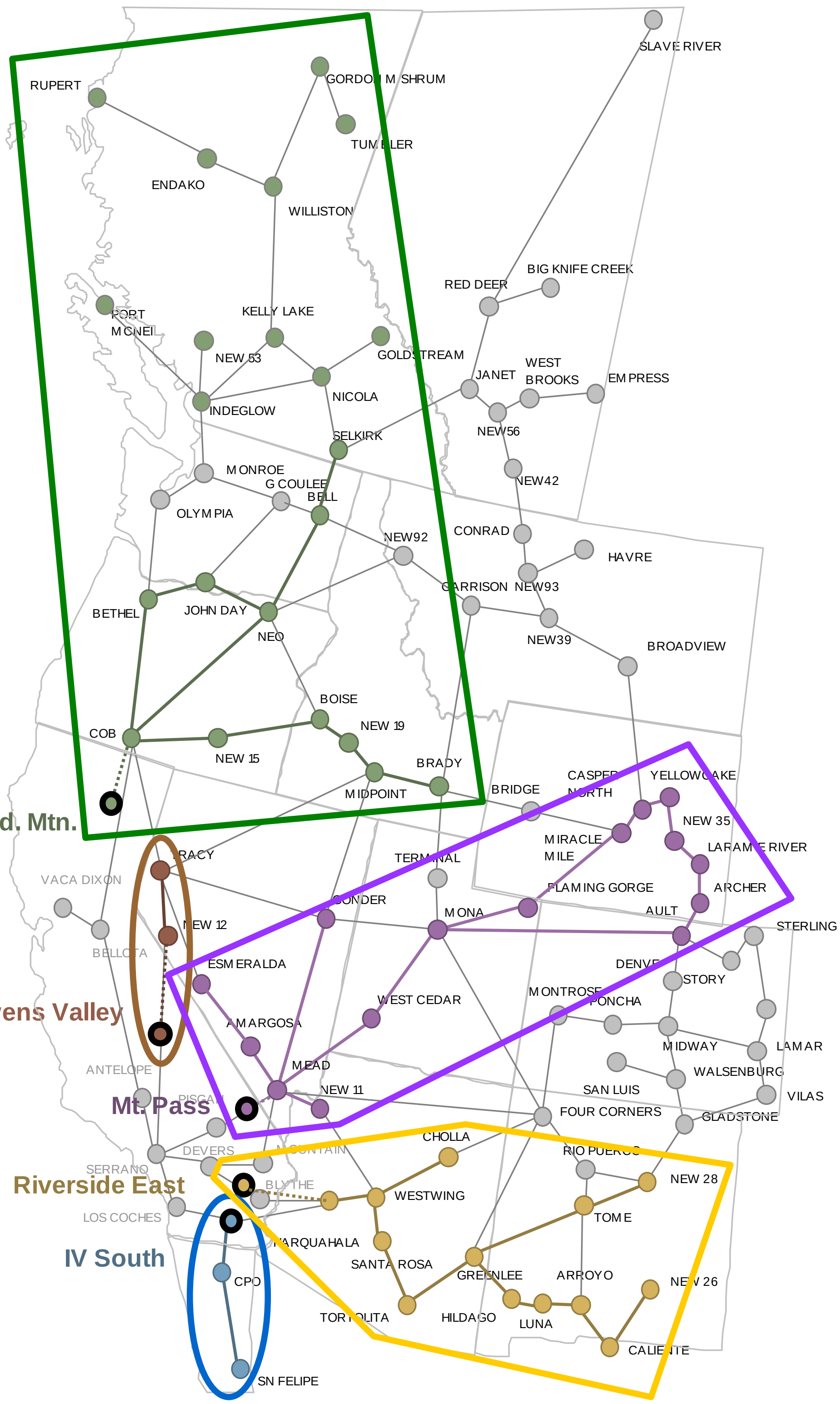
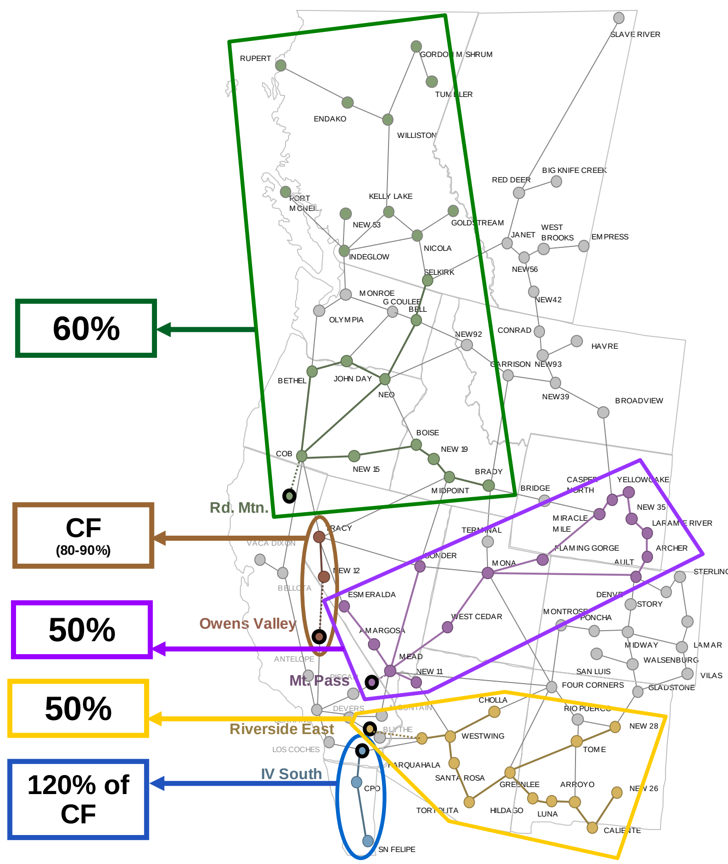


Figure 6-5. OOS Resource Regions and Corresponding Delivery Gateway CREZs.
Note: Gateway CREZs designated for economic calculations only and do not represent a preferred delivery path or delivery point of OOS resources.

6.5.4 Transmission Line Utilization

Transmission line utilization has a large bearing on the delivered cost of renewable energy. The higher the line utilization, the more energy that high transmission capital costs are spread over, and the lower the cost per MWh. For renewables, line utilization is largely determined by the resource mix of generation projects using that line. The different regions added to the RETI out-of-state resources have distinctly different resource mixes. Figure 6-6 explains the different resource mixes and shows the selected line utilizations for each region. The appropriate factors for transmission utilization were the subject of much discussion within the Phase 2A Working Group. However, the working group ultimately came to agree to use the numbers shown in Figure 6-6 as one possible scenario, while noting that actual line utilization will depend on which resources will ultimately be connected and where they will connect.

- **Pacific Northwest** has lots of existing transfer, blend of resources (including hydro, biomass, geothermal, wind) → use 60%
- **N. Nevada** is largely geothermal → use resource CF (80-90%)
- **WY/UT/S. NV** – additional study has shown overbuild is economic, use 50%
- **AZ/NM** – Mixed wind and solar; additional study has shown overbuild is economic, use 50%
- **Baja** is all wind → use + 120% of resource CF to account for overbuild and dynamic line ratings*



*Average Baja CF = 36%, average utilization = 43%
Note: Actual line utilization depends on which resources will ultimately be connected and where they will connect

Figure 6-6. Selected Line Utilization by Region.

The utilization assumptions were relatively straightforward for the Pacific Northwest, Nevada geothermal, and Baja wind. The Wyoming/Utah and Arizona/New Mexico regions represent a mix of resources and required more analysis. Due to the variable nature of wind and solar resources, overbuilding generation to increase transmission line utilization was found to be economic. Therefore, the line utilizations used for the Wyoming/Utah and Arizona/New Mexico regions are based on a study of the economic optimum of overbuild in those areas, as described in this further in this section.

Line utilization is not only based on what kind of resources are on a line, but also on where resources connect to the line. It should be noted that in the Arizona/New Mexico region, the resources in Arizona are much closer to California than the resources in New Mexico. Therefore, the actual resource mix on the line will not be as modeled over the entire distance of the transmission line.

Approach

In order to determine the appropriate line utilizations for the Wyoming/Utah and Arizona/New Mexico regions, Black & Veatch performed an optimization study. The basic steps for this study are as follows:

1. Obtain hourly generation data for the resources of interest
2. Combine the generation data for projects within a region in order to create a representative “combined” resource profile
3. Create generation duration curves in order to observe the maximum line utilization for the combined resources
4. Determine the economically optimal amount of overbuild
5. Determine the line utilization at the economically optimal overbuild

Generation Data

Because of the importance of understanding the maximum possible load on transmission, it is necessary to use finer data than the 12x24 resource profiles used elsewhere in the RETI project. Black & Veatch developed 8760 hr profiles with data for every hour of the year. Solar 8760 profiles were modeled using PVsyst and TMY2 solar data. The wind data is from NREL’s Western Wind and Solar Integration (WWSI) study, which has modeled 10-minute wind data for theoretical 30 MW projects at thousands of locations throughout the western U.S. The 10 minute site data was aggregated by hour and by either state or WREZ’s qualified resource areas.

Generation Duration Curves

In order to represent the appropriate resource mix, the generation data for multiple wind sites in Wyoming and Utah were then combined, as well as solar in Arizona and wind in New Mexico. The combined profiles were used to create generation duration curves, which can be used to show how often transmission lines would be near their maximum utilization. These curves are created by averaging the capacity factor by hour, sorting the data in descending order, and graphing it against percent of total hours. The area under the curve is equal to the overall resource capacity factor. For wind generation within a specified region, the data from 50 random sites, equaling 1,500 MW, was averaged by hour in order to accurately reflect the reduced variability from aggregating multiple sites. The effect of this can be seen in Figure 6-7.

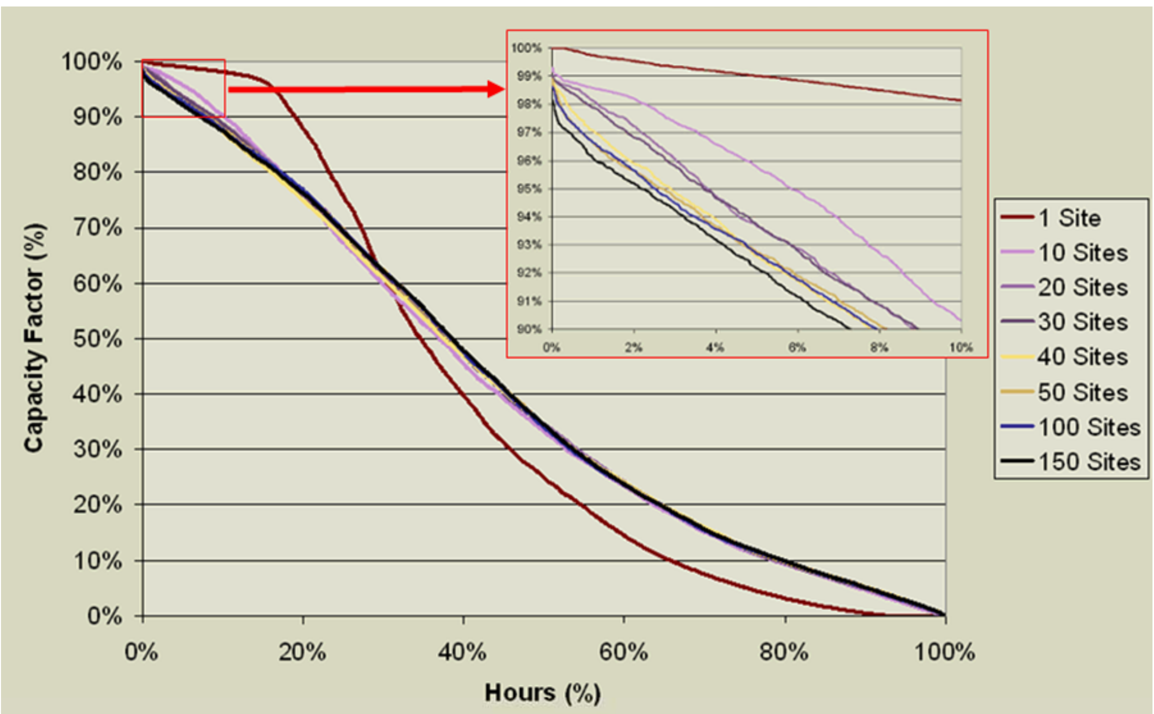


Figure 6-7. Generation Duration Curves for Various Numbers of Wind Sites in Wyoming.

When there is no overbuild, this curve would be equivalent to the load duration curve on a transmission line. In this case (Figure 6-7), using the curve for 50 sites, the transmission line utilization would be using above 90 percent of its capacity about 8 percent of the time. Figure 6-8 and Figure 6-9 show the combined duration curves representing the resource mixes in the two regions.

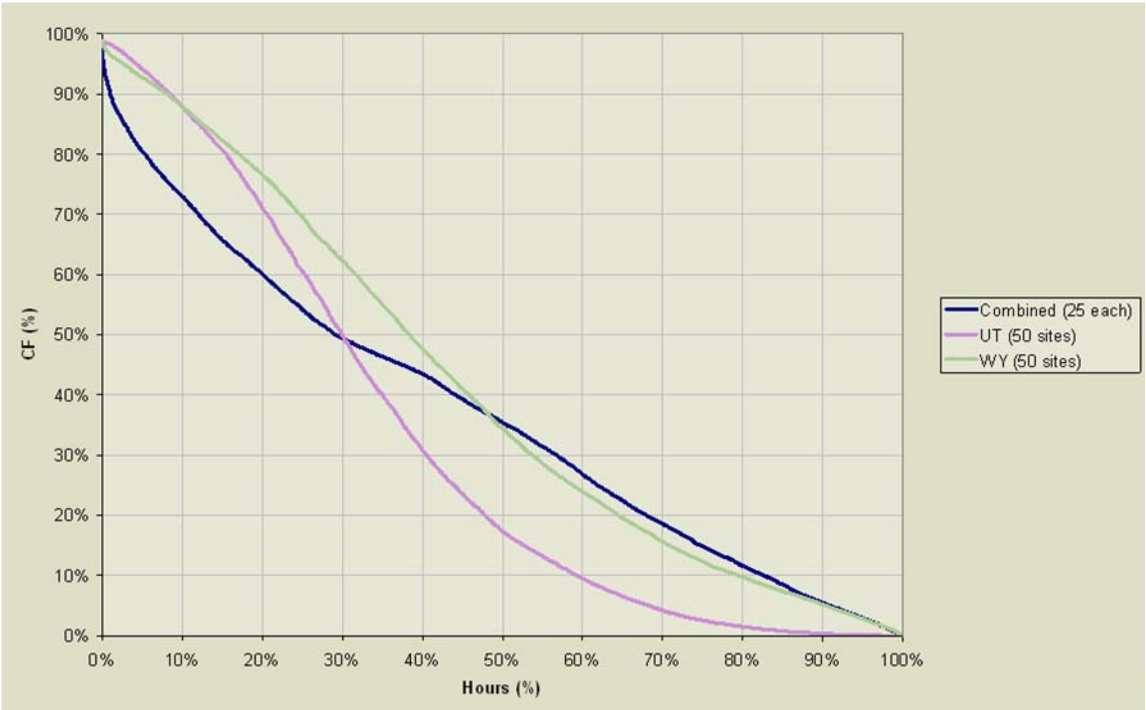


Figure 6-8. Combined Generation Duration Curve for Wyoming and Utah Wind.

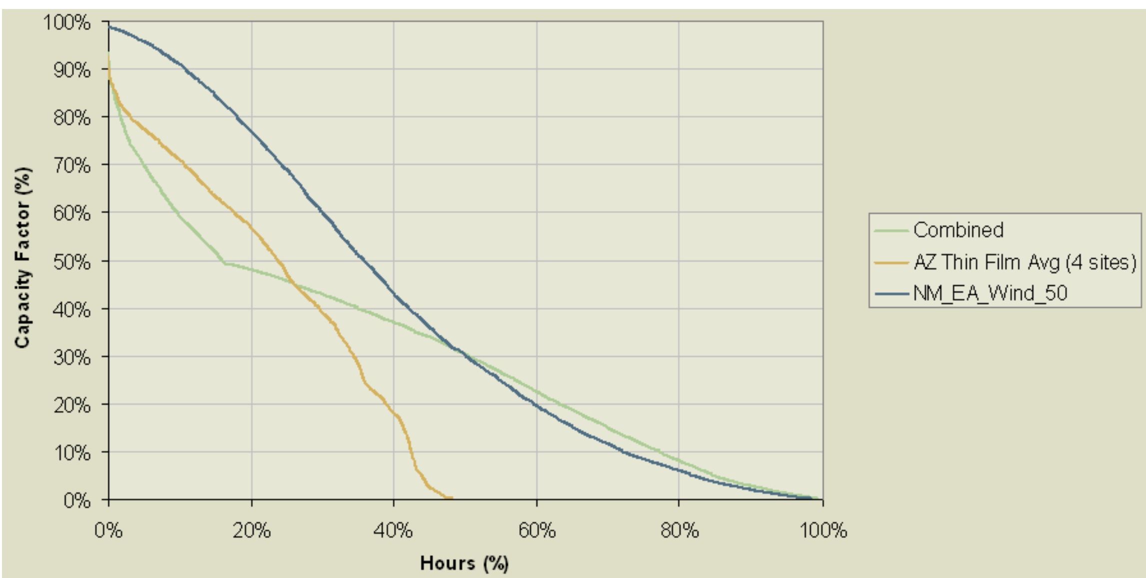


Figure 6-9. Combined Generation Duration Curve for Arizona Solar and New Mexico Wind.

Optimizing Overbuild

When considering dispatchable resources, or resources with a high capacity factor such as geothermal, it makes sense to match transmission line capacity and resource capacity. However, with variable resources such as wind, this would mean that the maximum capacity of generation projects would be limited by the small percent of hours with peak generation, also limiting the number of projects that can split the cost of transmission. If generation is intentionally overbuilt, there is a tradeoff between generation cost and transmission cost. The wind duration curves shown in Figure 6-10 illustrate this concept.

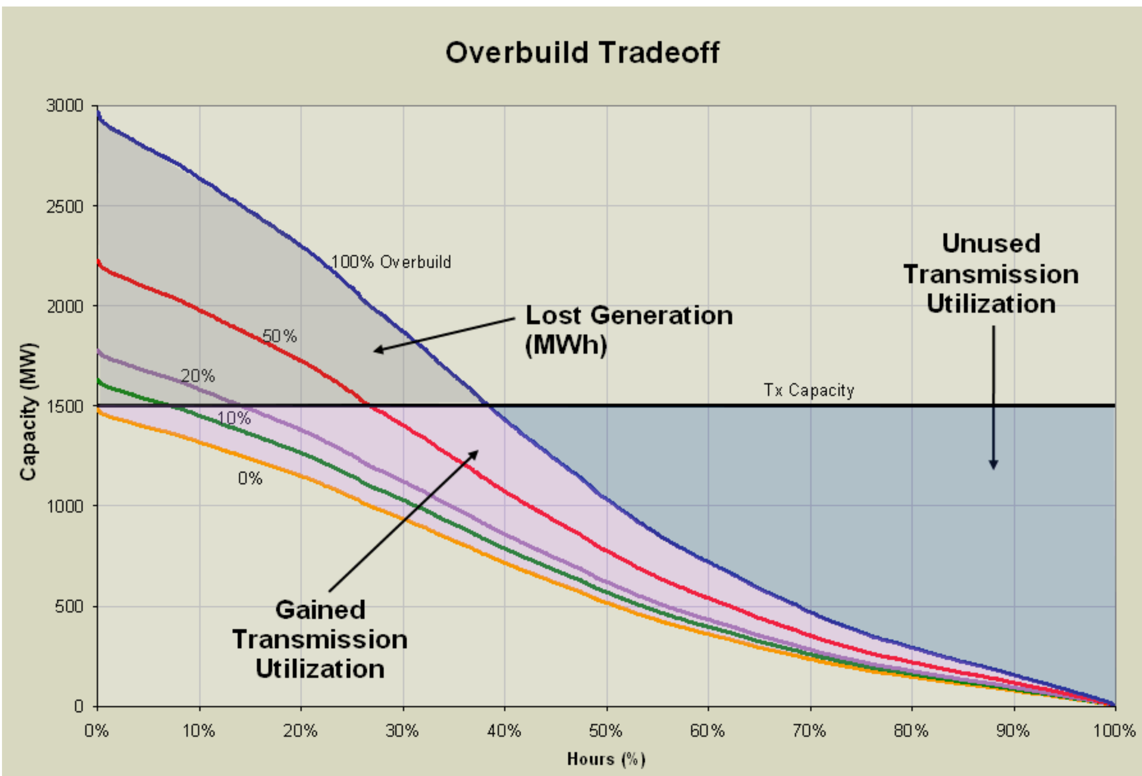


Figure 6-10. Tradeoff Between Generation and Transmission at Various Levels of Overbuild.

The black horizontal line shows the transmission line capacity of 1,500 MW. As the project capacity factor increases, generation is curtailed, increasing the cost of generation (area shaded in gray).[11] At the same time, transmission utilization (area shaded in purple) increases, decreasing the cost of transmission. The actual cost of each would be calculated by multiplying the area by the price. Because transmission is relatively inexpensive compared to generation, a larger area of gained line utilization would be necessary to justify the curtailed generation.

There are two different cost approaches to discovering the optimal overbuild: minimize the total cost, or minimize the adjusted delivered cost.[12] The differences between these two cost metrics are shown in the following formulas.

Total cost = Generation Cost + Transmission Cost

Adjusted Delivered Cost = Generation Cost + Transmission Cost - Energy Value – Capacity Value

During the study it was found that the minimum total cost and minimum adjusted delivered cost occur near the same overbuild amounts. Figure 6-11 shows these cost curves at overbuild levels from 0 percent to 100 percent for Wyoming wind. The costs are at their minimums when the amount of overbuild is about 20 percent, and the transmission utilization is about 48 percent.

[11] Curtailment risk will likely be a concern of generation developers. However, given the positive economics of overbuild as shown in this section, it was determined to be an acceptable approach by the Phase 2A Workgroup.
[12] Adjusted delivered cost is a WREZ metric that is very similar to RETI's rank cost metric.

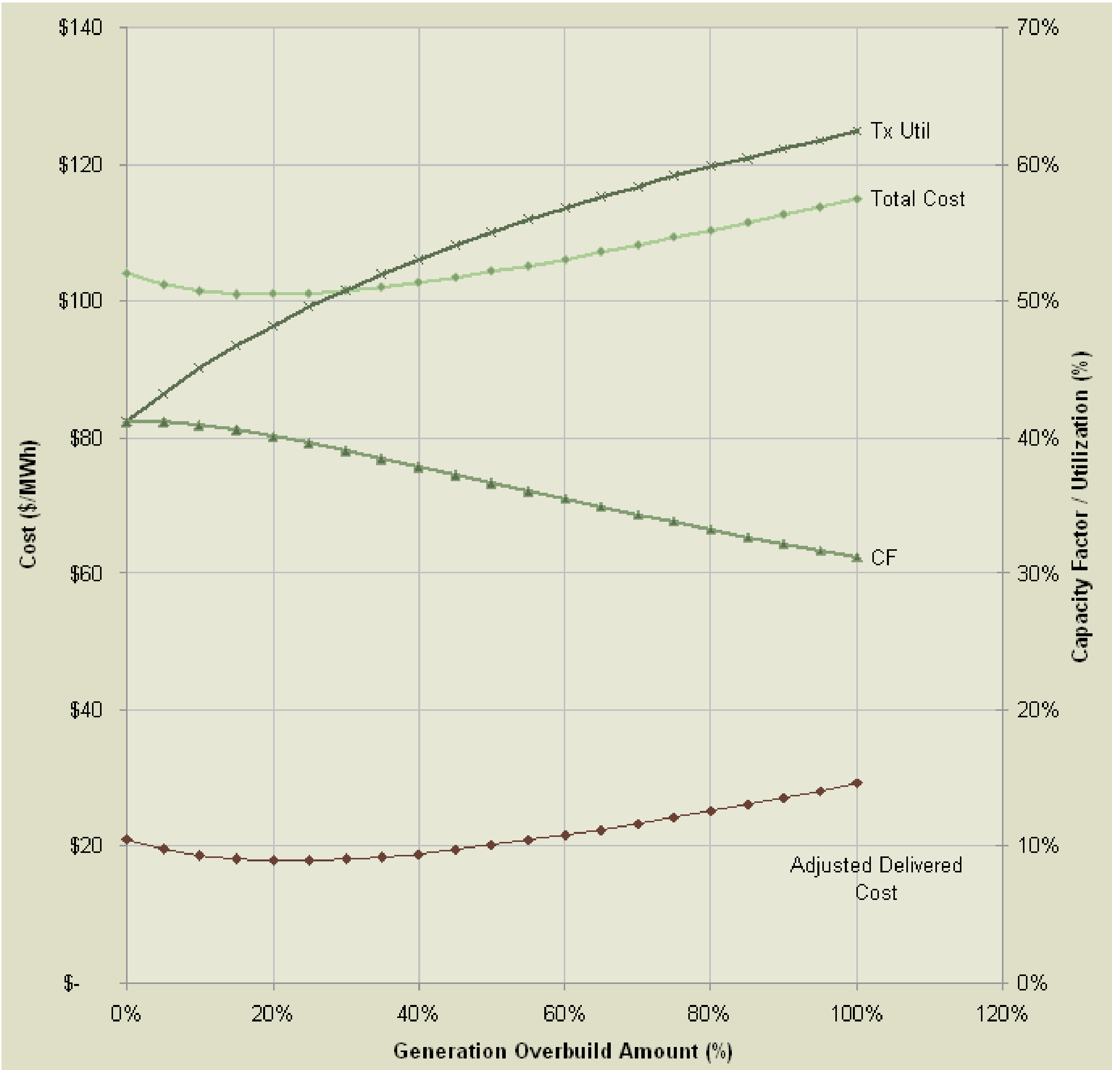


Figure 6-11. Overbuild Optimization for Wyoming Wind.

Another variable to consider when combining resources is the mix of resources used. Geographic diversity across states may allow for higher transmission line utilization, or resource diversity between wind and solar may achieve a similar effect. Therefore, the minimum total cost and minimum adjusted delivered cost costs at different resource mixes were calculated and compared. Figure 6-12 shows the costs and line utilizations at various resource mixes for the Wyoming/Utah region. Figure 6-12 shows that the optimum blend of Wyoming and Utah wind is actually 100 percent Wyoming wind – largely because Wyoming wind has a significantly higher capacity factor than Utah wind. On the other hand, it is shown that there is not a large increase in cost for adding up to about 40 percent Utah wind; the total cost goes from about $100/MWh to $105/MWh. At the same time, transmission utilization is about 50 percent across this range. The minimal impact on economics may facilitate regional transmission cooperation while maintaining high line utilizations.

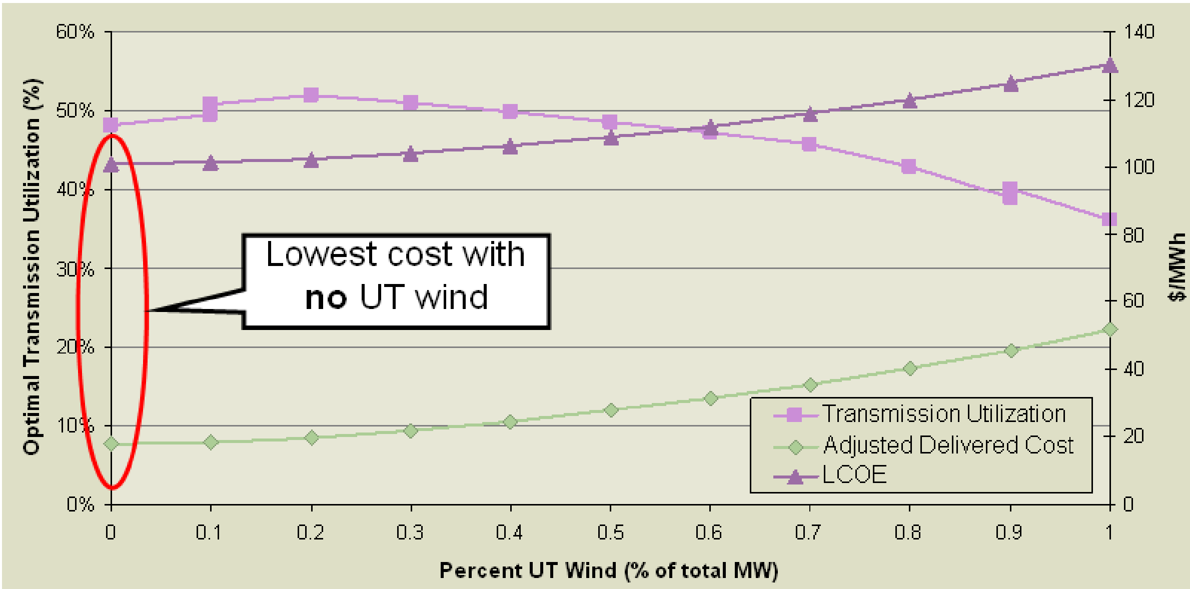


Figure 6-12. Costs and Line Utilization at Optimal Overbuild for Combinations of Utah and Wyoming Wind.

Figure 6-13 shows a similar chart combining New Mexico wind with Arizona solar. In this case, the lowest cost scenario is 100 percent wind from New Mexico. Adding up to 20 percent solar would increase the line utilization to near 50 percent with a relatively small impact on cost.

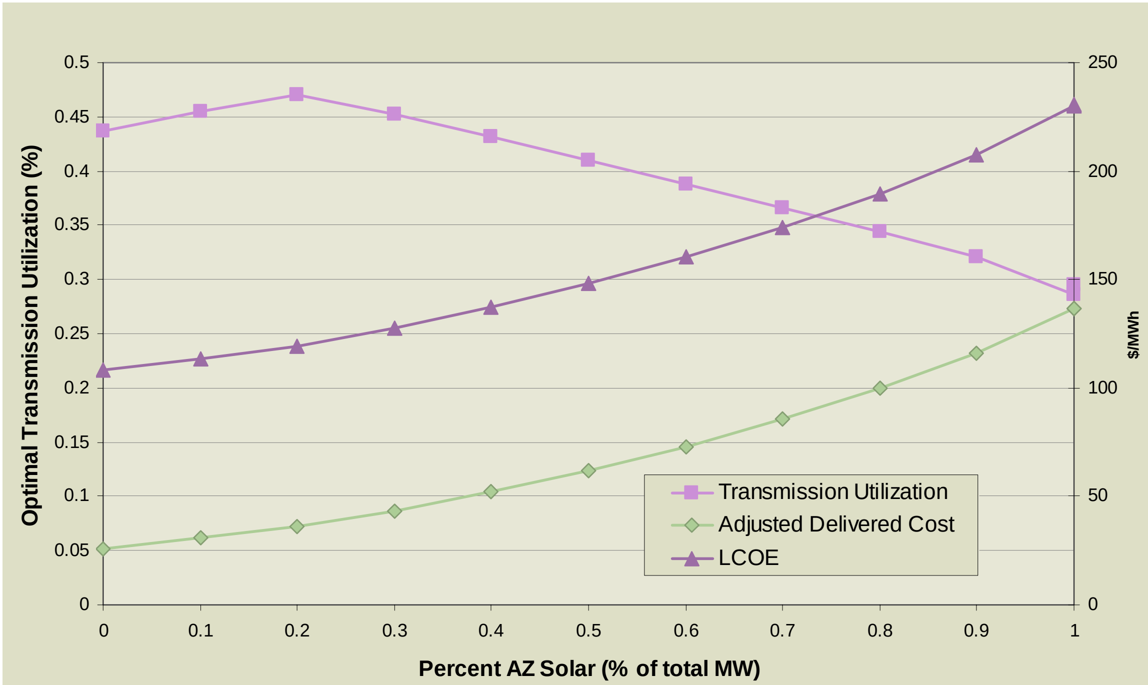


Figure 6-13. Costs and Line Utilization at Optimal Overbuild for Combinations of Arizona Solar and New Mexico Wind.

Line Utilization Results

The exact blend of resources which will use new transmission lines in the West is impossible to determine at this point. In fact, there is nothing restricting existing resources and new fossil fuel resources from using the lines. However, even if the lines use only new renewables, this analysis has shown that it is feasible to overbuild generation capacity relative to transmission capacity. Furthermore, it is possible to blend resources from different areas to increase line utilization with modest impacts on cost. Based on the analyses presented in this section, the Phase 2A Workgroup felt it was reasonable to assume 50 percent line utilization when determining the transmission cost for the Wyoming/Utah and Arizona/New Mexico regions. The actual line utilization would depend on the resources connected.

6.5.5 Transmission Cost Results

The map in Figure 6-14 shows the resulting transmission costs for each resource area based on the assumptions discussed in this section. Grey circles represent resources that were not included in the OOS analysis as described earlier in this section.

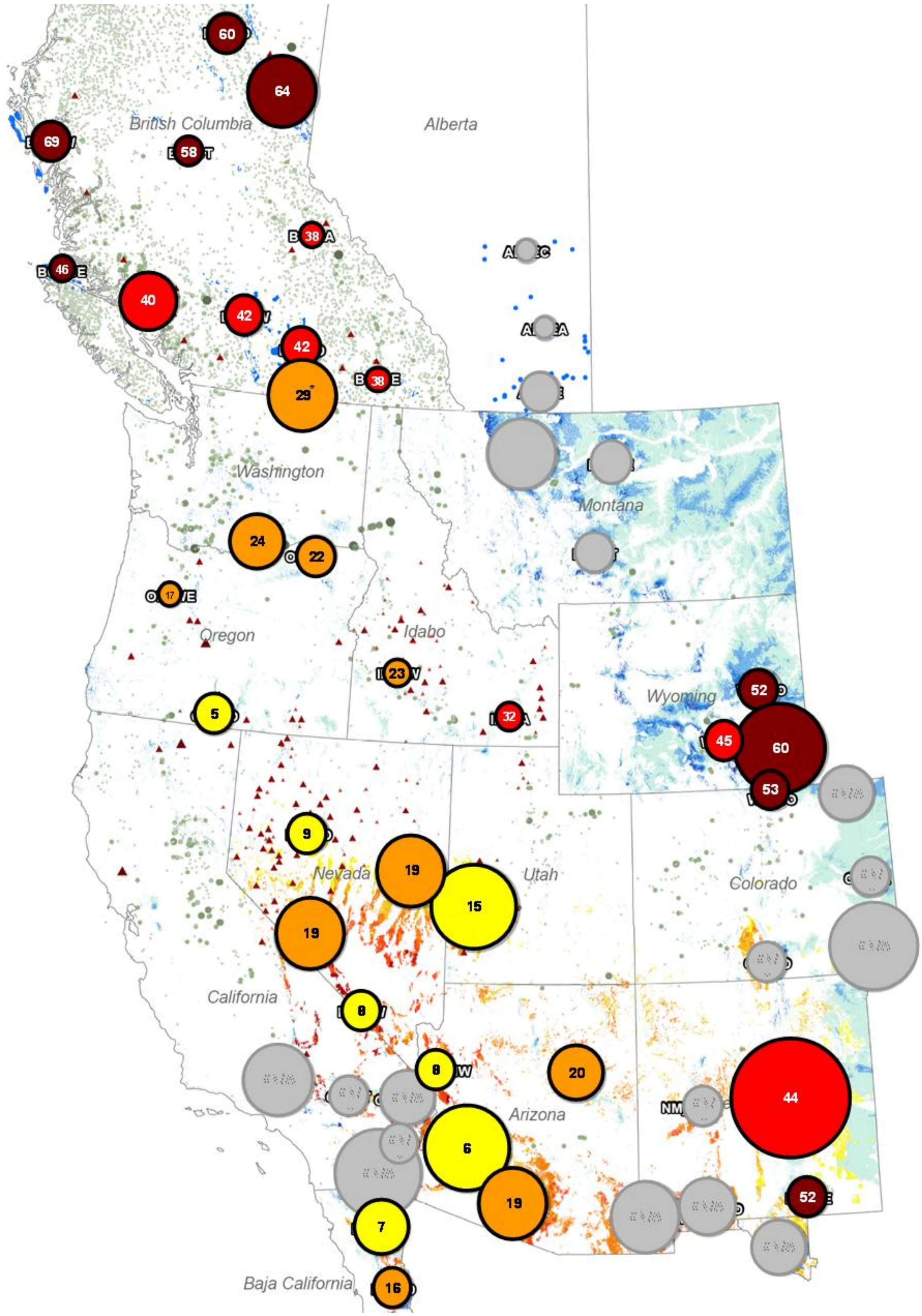


Figure 6-14. OOS Transmission Costs ($/MWh), Delivered to Gateway CREZ.
*Special BC shaped product described in Section 7.4.4.

6.6 Out-of-state Results

The following figures summarize the out-of-state resource capacity included in the RETI model based on the updates described above. The economics for the resources are presented in the next section.

Table 6-5. Out-of-State Resource Estimates (MW).

Region	Biomass	Geothermal	Solar	Wind	Total
AZ	329		19,782	3,714	23,825
BC	939	340		13,942	15,221
BJ				8,305	8,305
ID	358	329		1,649	2,336
NM				13,186	13,186
NV	299	1,459	18,588	1,754	22,099
OR	454	403		2,913	3,770
UT	90	375		1,679	2,144
WA	449			3,262	3,711
WY				14,853	14,853
Total	**2,918**	**2,906**	**38,370**	**65,257**	**109,451**

Notes: Oregon geothermal in WREZ includes northern California resources which were removed to prevent double counting. Geothermal projects already under contract to NV Energy were also removed. In WREZ, solar PV and solar thermal were assumed to occupy the same general area, and therefore the estimate could apply to either technology. (RETI estimated site-specific capacity for both technologies in California.)

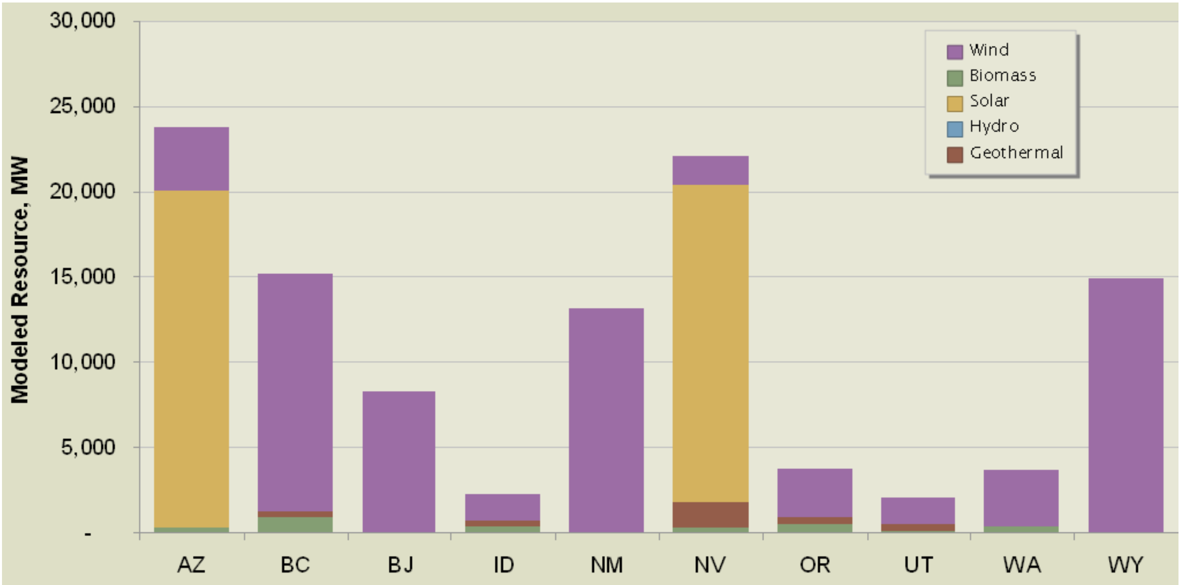


Figure 6-15. Out-of-State Resource Estimates (MW).

7.0 Results

Black & Veatch developed updated rank costs for each resource identified in RETI using the methodology originally conceived in Phase 1 of RETI. The rank costs were aggregated into weighted average rank costs for each CREZ, and were also used to develop supply curves for each CREZ. In addition, the resource supply curves were subjected to uncertainty and sensitivity analyses to determine if the curves fairly represented a robust range of resource costs. Finally, the updated economic analysis results were integrated with revised environmental scores. This section presents the results of this updated analysis. For further details on the methodology for developing the rank costs, please refer to the RETI Phase 1B report.

7.1 CREZ Rank Costs

Table 7-1 shows the weighted average rank cost for all CREZs in California. The rank cost for a resource includes the cost of generation and transmission, less the capacity and energy value. The net capacity of the CREZ, annual energy generation potential, and weighted average rank cost are shown in Table 7-1, along with the cumulative energy generation potential of all CREZs to that point. The cumulative potential is important when determining the amount of generation needed to cover the expected RETI net short. Generally, the relative rankings of the CREZs are comparable to previous RETI results. Compared to RETI Phase 1B, the top five CREZs are the same, except that Santa Barbara replaces the Victorville CREZ. Wind-dominated CREZs did comparatively better than solar CREZs, largely due to the new 30 percent grant / ITC assumed to be available for wind (solar had already been eligible for the ITC).

Table 7-2 adds out-of-state resource areas for comparison. The out-of-state resource areas are highlighted in yellow. The out-of-state resources are generally higher rank cost than the in-state resources, largely due to high assumed transmission costs as explained later in this section.

Table 7-1. Weighted Average California CREZ Rank Costs.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)[a]	Cumulative Energy (GWh/yr)[a]	Weighted Average Rank Cost ($/MWh)[b]	Rank Cost Change from Phase 1B
Solano	894	2,721	2,721	-21	8
Palm Springs	333	1,047	3,768	-18	2
Round Mountain-A	384	2,557	6,325	-6	5
Imperial North-A	1,370	10,095	16,419	4	17
Santa Barbara	433	1,121	17,540	4	-39
Fairmont	2,200	6,015	23,555	7	16
San Diego South	678	1,829	25,385	9	-7
Tehachapi	8,626	21,411	46,795	11	14
San Diego North Central	200	502	47,297	15	-4
Lassen South	410	1,051	48,348	18	4[d]
Victorville	1,336	3,196	51,545	18	18[c]
Round Mountain-B	132	339	51,883	19	-2
Barstow	1,986	4,706	56,589	19	-19
San Bernardino - Lucerne	1,845	4,829	61,418	21	5
Lassen North	1,467	3,595	65,013	24	2[d]
Kramer	4,866	11,092	76,106	25	20
Inyokern	1,896	4,315	80,421	29	21
Mountain Pass	763	1,741	82,162	32	5
Twentynine Palms	1,354	3,012	85,174	33	18
Pisgah	1,650	3,680	88,854	34	18[d]
Cuyama	300	638	89,492	35	11
Carrizo South	2,250	4,721	94,213	38	19
San Bernardino - Baker	2,513	5,540	99,752	38	-3
Carrizo North	1,200	2,501	102,254	38	10
Imperial East	1,199	2,708	104,961	41	7
Riverside East	7,913	17,504	122,466	41	21[c]
Westlands	3,750	7,467	129,933	42	N/A
Imperial North-B	1,380	3,190	133,123	53	24
Imperial South	2,823	6,714	139,836	54	23
Owens Valley	3,750	8,194	148,030	56	46
Iron Mountain	3,662	8,133	156,163	64	37

Note:
[a] Includes transmission losses
[b] Includes modifications as described in previous sections.
[c] Weighted average of corresponding sub-CREZs in Phase 1B
[d] Value from Phase 1B sub-CREZ A only

Table 7-2. Weighted Average Rank Costs: All CREZ and Resource Areas.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)*	Cumulative Energy (GWh/yr)*	Weighted Average Rank Cost ($/MWh)
Solano	894	2,721	2,721	-21
Palm Springs	333	1,047	3,768	-18
Round Mountain-A	384	2,557	6,325	-6
Imperial North-A	1,370	10,095	16,419	4
Santa Barbara	433	1,121	17,540	4
Fairmont	2,200	6,015	23,555	7
San Diego South	678	1,829	25,385	9
Tehachapi	8,626	21,411	46,795	11
San Diego North Central	200	502	47,297	15
Lassen South	410	1,051	48,348	18
Victorville	1,336	3,196	51,545	18
Round Mountain-B	132	339	51,883	19
Barstow	1,986	4,706	56,589	19
UT_WE	2,144	7,595	64,184	20
San Bernardino - Lucerne	1,845	4,829	69,013	21
Lassen North	1,467	3,595	72,608	24
Kramer	4,866	11,092	83,700	25
OR_SO	669	2,443	86,143	25
Inyokern	1,896	4,315	90,459	29
OR_WE	970	5,393	95,851	29
NV_NO	1,248	8,389	104,240	30
Mountain Pass	763	1,741	105,982	32
Twentynine Palms	1,354	3,012	108,993	33
Pisgah	1,650	3,680	112,673	34
Cuyama	300	638	113,311	35
OR_NE	2,089	5,719	119,031	35
Carrizo South	2,250	4,721	123,751	38
San Bernardino - Baker	2,513	5,540	129,291	38
Carrizo North	1,200	2,501	131,792	38
Imperial East	1,199	2,708	134,500	41
Riverside East	7,913	17,504	152,004	41
Westlands	3,750	7,467	159,472	42
ID_SW	1,158	3,906	163,378	45
WY_EC	2,595	8,236	171,614	45
AZ_NE	4,063	11,694	183,308	46
NV_SW	5,042	12,501	195,809	49
WA_SO	3,752	11,942	207,751	51
Imperial North-B	1,380	3,190	210,941	53
Imperial South	2,823	6,714	217,655	54
ID_EA	1,178	4,934	222,589	54
Owens Valley	3,750	8,194	230,782	56
BJ_NO	5,655	16,635	247,417	56
WY_SO	1,940	5,813	253,230	57
AZ_NW	3,758	9,168	262,397	58
NM_EA	11,292	31,626	294,023	58

Table 7-2. Weighted Average Rank Costs: All CREZ and Resource Areas.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)*	Cumulative Energy (GWh/yr)*	Weighted Average Rank Cost ($/MWh)
AZ_WE	9,373	23,130	317,153	58
WY_NO	3,061	9,217	326,369	58
NV_WE	7,836	20,109	346,479	61
WY_EA	7,257	22,690	369,169	62
Iron Mountain	3,662	8,133	377,302	64
NM_SE	1,894	5,376	382,678	65
BJ_SO	2,650	7,973	390,651	73
NV_EA	7,974	19,332	409,984	73
AZ_SO	6,631	16,265	426,249	76
BC_WC	307	2,121	428,370	95
BC_EA	66	429	428,799	130
BC_SE	230	829	429,627	140
BC_WE	1,370	3,194	432,821	142
BC_NE	4,206	10,638	443,459	148
BC_SW	1,922	4,424	447,883	155
BC_SO	2,441	5,208	453,092	157
BC_NO	2,254	5,486	458,577	161
BC_CT	1,024	2,497	461,074	176
BC_NW	1,402	3,442	464,516	185

Note:
* Includes transmission losses

7.2 Resource Supply Curves

A supply curve is a very useful way of depicting an array of resource options that offer different quantities and costs. A supply curve represents the quantity of a product that is available at a particular price (e.g., the amount of renewable energy that can be generated within a utility system for under $50/MWh). The supply curve is constructed by plotting the amount of generation or capacity added by each resource against its corresponding levelized cost. For RETI, the incremental generation from each CREZ is plotted against its rank cost in ascending order.

Figure 7-1 depicts the supply curve for all California CREZs and out-of-state resource areas using the weighted average rank costs from Table 7-2. The potential generation (GWh/yr) is on the x-axis and rank cost ($/MWh) is shown on the y-axis. To develop this curve, the CREZ rank costs were sorted from lowest to highest and plotted versus cumulative generation to develop one curve for comparing all the CREZs. Figure 7-2 highlights the top CREZ's by "zooming" into the best 200,000 GWh/yr.

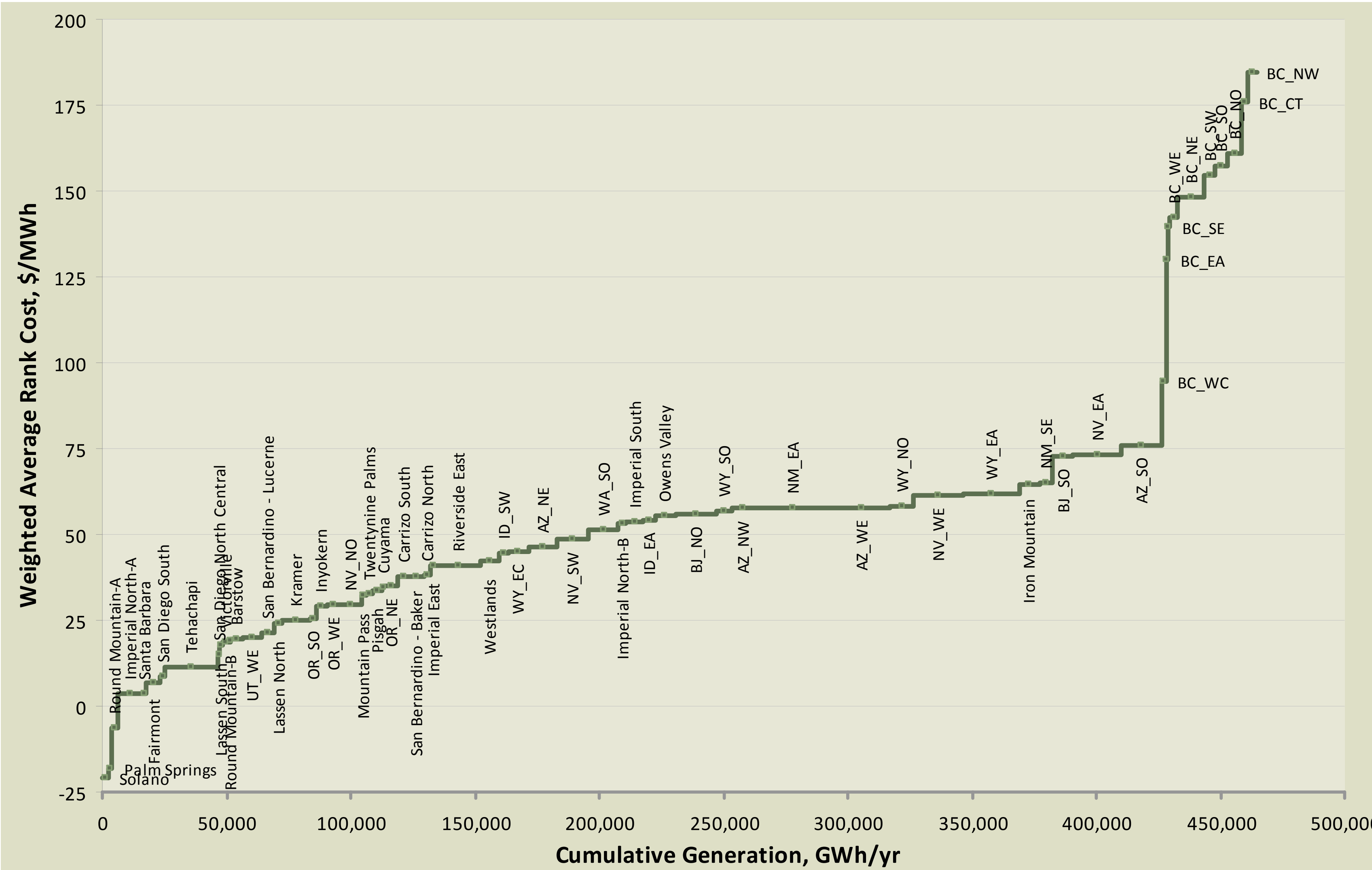


Figure 7-1. Weighted Average Rank Cost (2010 $/MWh) for CREZs.

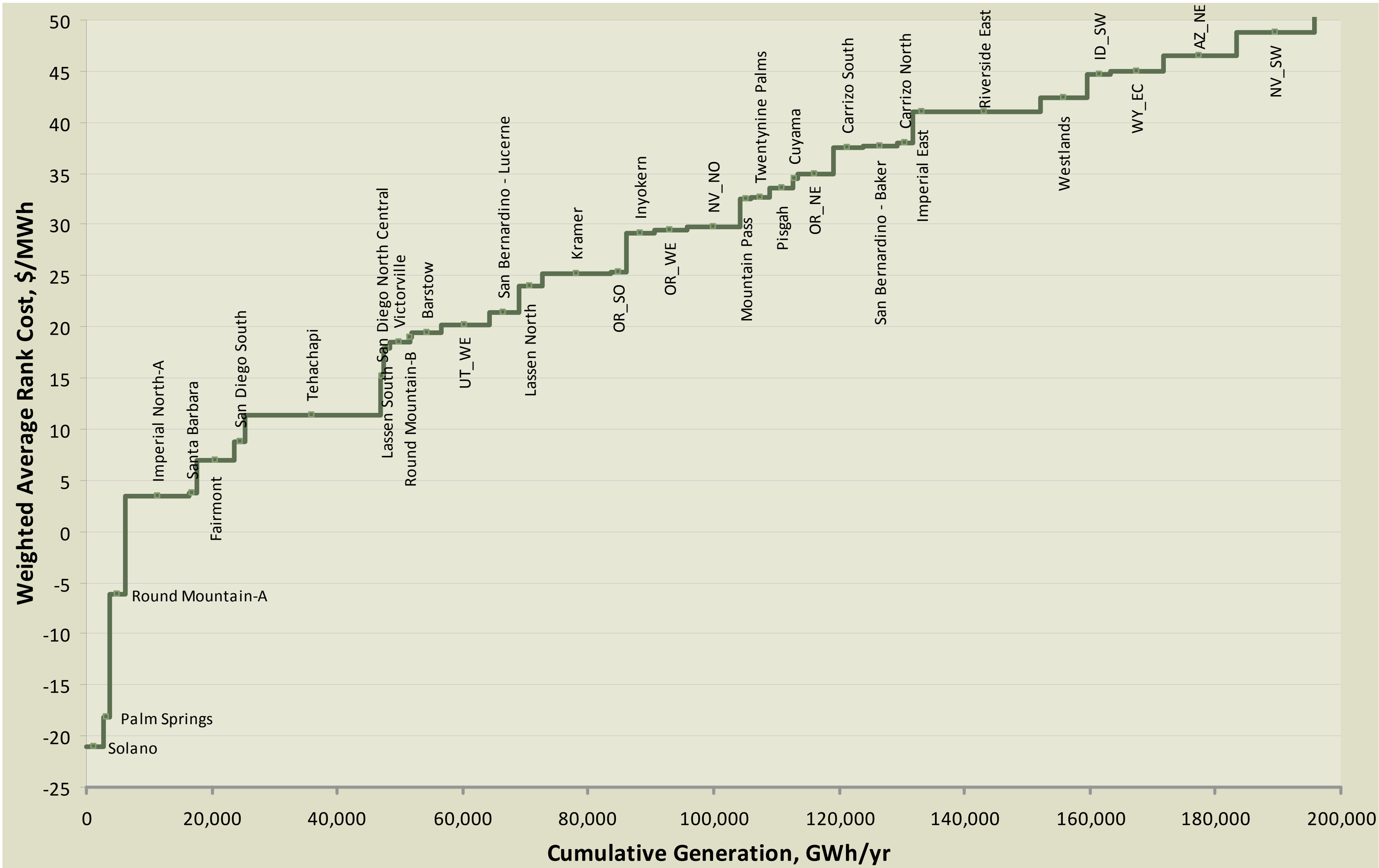


Figure 7-2. Weighted Average Rank Cost (2010 $/MWh) for CREZs (Zoomed).

7.3 Results – Top Economic Ranked CREZs

Table 7-3 shows the results for the top 21 in-state and out-of-state CREZs resources that could most economically be used to meet the RETI net short. The cumulative is about 100,000 GWh/yr, which exceeds the estimated net short of approximately 50,000 GWh/yr. CREZs above the net short were shown since it is likely that additional resources may be necessary above the net short to account for uncertainty in the resource assessment approach, to ensure geographic diversity, and other factors.

Table 7-3. Economic Analysis Results: Base Case.

CREZ Name	Annual Energy (GWh/yr)	Cumulative Energy (GWh/yr)	Weighted Average Rank Cost ($/MWh)
Solano	2,721	2,721	-21
Palm Springs	1,047	3,768	-18
Round Mountain-A	2,557	6,325	-6
Imperial North-A	10,095	16,419	4
Santa Barbara	1,121	17,540	4
Fairmont	6,015	23,555	7
San Diego South	1,829	25,385	9
Tehachapi	21,411	46,795	11
San Diego North Central	502	47,297	15
Lassen South	1,051	48,348	18
Victorville	3,196	51,545	18
Round Mountain-B	339	51,883	19
Barstow	4,706	56,589	19
UT_WE	7,595	64,184	20
San Bernardino - Lucerne	4,829	69,013	21
Lassen North	3,595	72,608	24
Kramer	11,092	83,700	25
OR_SO	2,443	86,143	25
Inyokern	4,315	90,459	29
OR_WE	5,393	95,851	29
NV_NO	8,389	104,240	30

The top ten economic ranked CREZs are:

- Solano
- Palm Springs
- Round Mountain-A
- Imperial North-A
- Santa Barbara
- Fairmont
- San Diego South
- Tehachapi
- San Diego North Central
- Lassen South

As mentioned earlier, the majority of the best resources are located in California, with only four out-of-state areas identified in Table 7-3. However, changes in certain key assumptions could change these results, as explored in the next section.

7.4 Uncertainty and Sensitivity Analyses

It is very important to consider the uncertainty in the estimates used to quantify and value resources. By their very nature, these estimates include a margin of error due to the assumptions made by the RETI team. The methodology use to assess uncertainty is similar to that presented in the Phase 1B report.

Uncertainty analysis was limited to a set of key variables reviewed by the Phase 2B Workgroup. Evaluation was prioritized on (1) major variables that can significantly change the CREZ rankings and (2) variables whose uncertainty may differentially impact CREZ ranking. For example, a change in load growth will probably not favor one CREZ over another.

Based on these principles, and the insights gained from the uncertainty analysis performed for Phase 1B it was determined to ignore uncertainty in the net short calculation, financing assumptions, operating and maintenance costs, capacity value[13], energy value, development potential, and integration costs. It was further determined that certain assumptions lend themselves to evaluation using sensitivity scenarios instead of uncertainty bounds. These include the following:

- Tax credits

[13] RETI Phase 1 considered capacity values of $204/kW-yr and $102/kW-yr. The mean value was used for this update: $153/kW-yr.

- Out-of-state transmission costs
- Shaping and firming of resources (British Columbia example)
- Advanced solar thermal technologies costs
- Distributed solar photovoltaics

Additional assumptions that could impact CREZ rankings are associated with uncertainty in project capital and resource costs (capacity factor or fuel cost depending on the technology). The cost uncertainty assessment is detailed first, followed by discussion of the sensitivity analysis performed for the five variables bulleted above.

7.4.1 Uncertainty Assessment

The methodology used to assess uncertainty for the Phase 2B report is identical to that described in the Phase 1B report.[14] Capital cost, capacity factor, and fuel cost were the major variables identified to quantify economic uncertainty. Reasonable ranges of percentage uncertainty for each variable for each technology were established in Phase 1B (for example: +/-20 percent in geothermal capital cost). New technology and incentive assumptions developed for the Phase 2B report resulted in new average values for the key variables. The uncertainty ranges developed for Phase 1B were then applied to these average values. The variation in cost of generation based on the combined simultaneous variation in inputs is summarized in Table 7-4 for each technology. The percentage ranges shown in Table 7-4 are similar to those calculated for Phase 1B.

Table 7-4. Calculated Uncertainty Band for Typical Projects.

	Absolute Generation Cost Ranges ($/MWh)			Relative Range ($/MWh)*		Percentage Range	
	Low	Base	High	Low	High	Low	High
Geothermal	$80	$96	$112	-$17	$15	-17%	16%
Biomass	$97	$119	$143	-$22	$24	-18%	20%
Wind	$61	$83	$111	-$22	$28	-26%	34%
Solar Thermal	$177	$213	$256	-$35	$43	-17%	20%
Solar PV Crystalline	$143	$164	$190	-$21	$26	-13%	16%
Solar PV Thin Film	$135	$155	$180	-$20	$25	-13%	16%

*Relative range shows the difference from the base cost in order to indicate the upper and lower bounds for calculating uncertainty

The uncertainty bands were then applied to each project, and new high and low weighted average CREZ rank costs were calculated. These have been added to the CREZ

[14] Please refer to the Phase 1B report for a more detailed description of the methodology.

supply curve, as shown in Figure 7-3. Figure 7-4 highlights the top CREZs by zooming in on the least cost 200,000 GWh/yr.

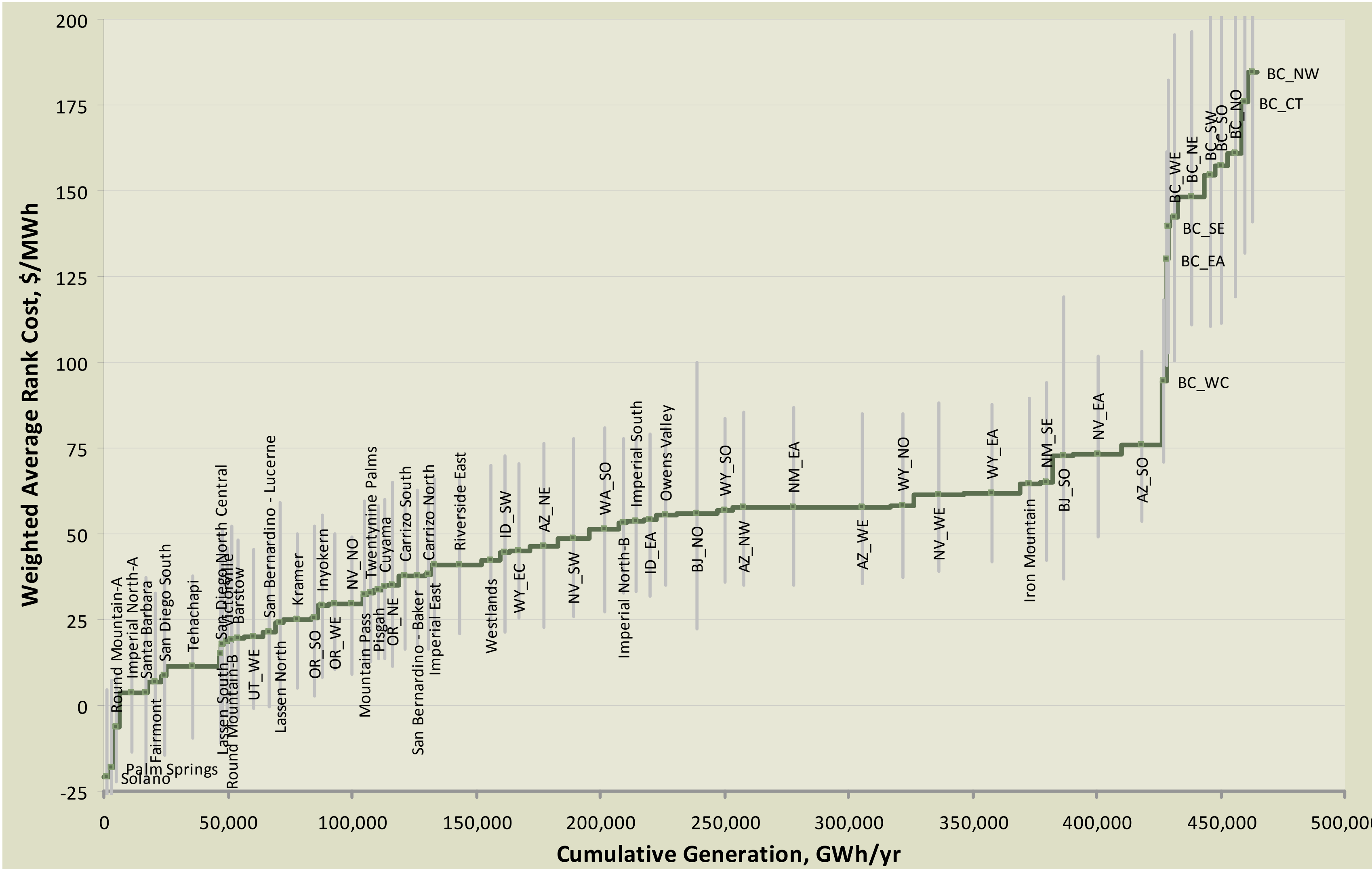


Figure 7-3. Supply Curve with Uncertainty Bands.

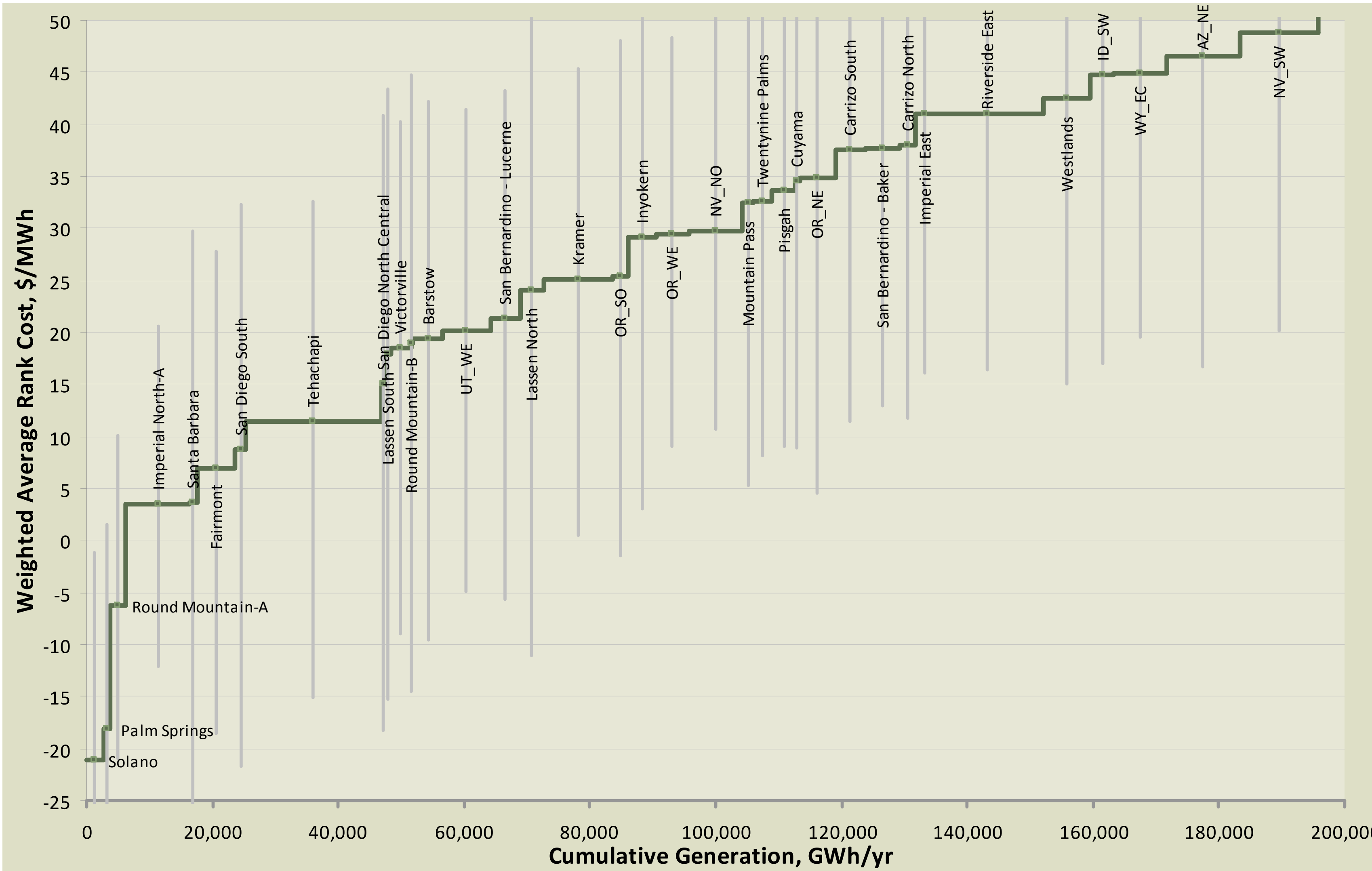


Figure 7-4. Supply Curve with Uncertainty Bands (zoomed).

Figure 7-3 is useful in communicating the overall level of uncertainty that can be ascribed to the analysis. There is significant overlap in the uncertainty bands, which indicates considerable uncertainty in identifying a discrete set of clear CREZ priorities. The uncertainty results indicate that many CREZs may be competitive with the most economic CREZs once uncertainty is considered. Assuming all projects are successfully developed, the RETI net short could theoretically be satisfied at a rank cost of about $10/MWh to $15/MWh. If costs are at the low end of the uncertainty range, there are many other resources that could be competitive with this range. These additional resources are those shown in Figure 7-3 whose lower uncertainty band drops below the $10/MWh to $15/MWh range.

7.4.2 Sensitivity Analysis – Elimination of Tax Credits

A sensitivity run was made to evaluate the effect that tax credits have on the CREZ rank results. To perform this assessment, the following steps were taken:

- The ability to claim the production tax credit was removed for wind, biomass, and geothermal
- The ability to claim the 30 percent grant / investment tax credit was eliminated for solar, wind, biomass, and geothermal
- No changes were made for accelerated deprecation assumptions or for projects in Mexico and Canada.

Figure 7-5 shows the original supply curve from Figure 7-1 (green) with an alternate supply curve removing U.S. tax credits. The alternate supply curve is shown in red. The red supply curve is simply the original curve less the effects of the tax credits. The difference between the two is the impact of the tax credits on the average rank cost for each resource. From this chart it is clear that Mexican and Canadian resources benefit from the higher costs of U.S. projects. However, Canadian resources are still relatively high rank cost. While the economics of all U.S. resources are hurt by elimination of the tax credit, costs for solar are more severely impacted such that the resource loses competitiveness.

The results are summarized in Table 7-5. These can be compared to Table 7-3, which shows the base case results. Additional CREZs that enter the top 100,000 GWh/yr of supply are highlighted in Table 7-5 in yellow.

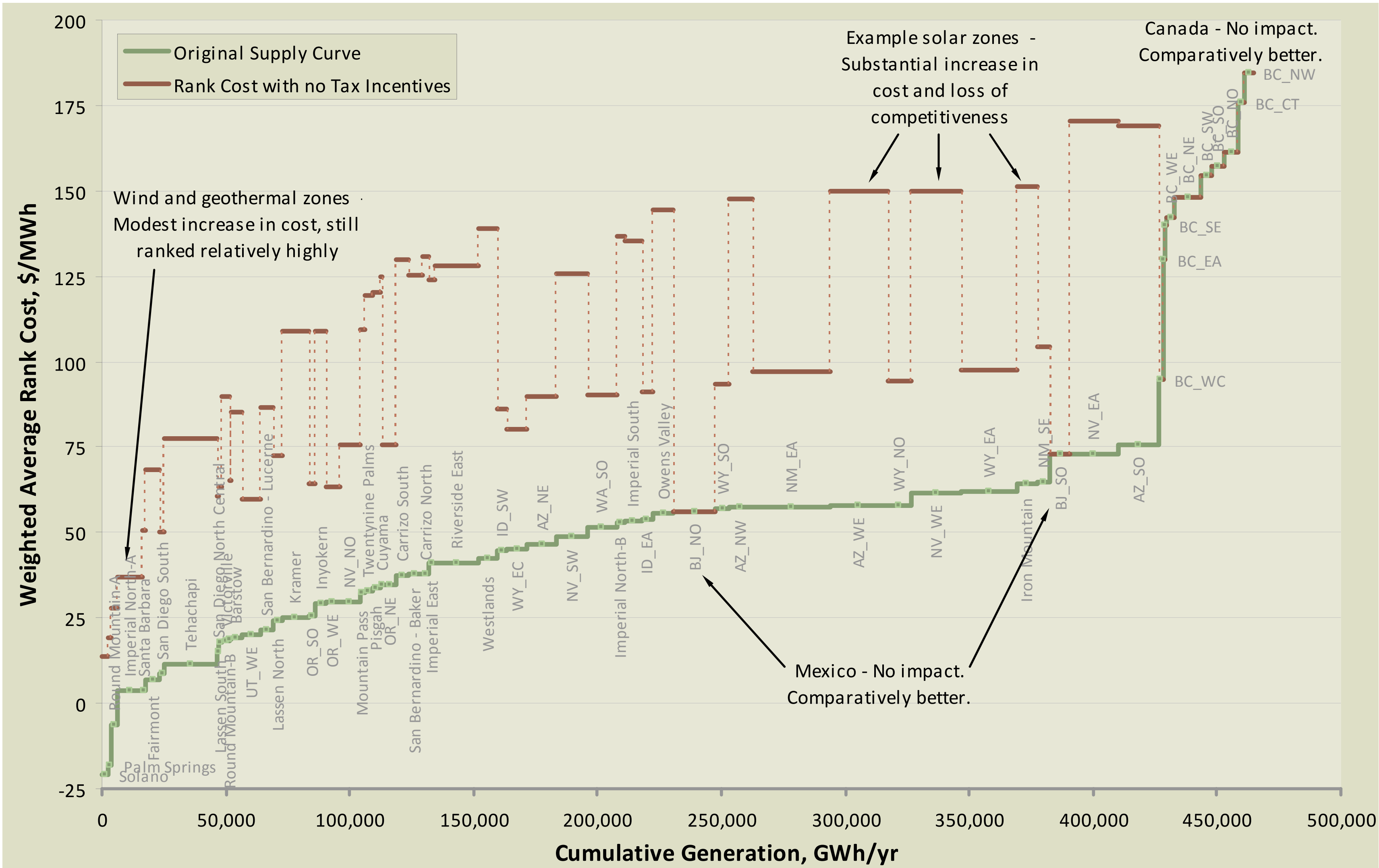


Figure 7-5. Impact of Elimination of Tax Credits.

Table 7-5. Economic Analysis Results: No Tax Credit Sensitivity.

CREZ Name	Annual Energy (GWh/yr)	Cumulative Energy (GWh/yr)	Weighted Average Rank Cost ($/MWh)
Solano	2,721	2,721	14
Palm Springs	1,047	3,768	19
Round Mountain-A	2,557	6,325	28
Imperial North-A	10,095	16,419	37
San Diego South	1,829	18,249	50
Santa Barbara	1,121	19,370	51
BJ_NO	16,635	36,005	56
UT_WE	7,595	43,599	60
San Diego North Central	502	44,101	61
OR_WE	5,393	49,494	63
Lassen South	1,051	50,545	63
OR_SO	2,443	52,988	64
Round Mountain-B	339	53,327	65
Fairmont	6,015	59,341	68
Lassen North	3,595	62,936	72
BJ_SO	7,973	70,909	73
OR_NE	5,719	76,629	76
NV_NO	8,389	85,018	76
Tehachapi	21,411	106,429	78
*CREZs highlighted in yellow are not in the base case results			

The tables show that despite the substantial increases in cost, there are relatively few changes to the top ranked resources. There are three new CREZs which may be viable under this scenario. These include all the Baja California wind resources and wind from northeastern Oregon.

7.4.3 Sensitivity Analysis – Out-of-state Transmission Costs

As discussed in Section 6, transmission costs to deliver renewable energy to California can comprise a large component of the overall cost of an out-of-state resource. In evaluating out-of-state resources, Black & Veatch had to identify a set of "default" assumptions to estimate transmission costs. These assumptions were agreed to by the Phase 2B Workgroup for the sake of consistency, even though it was recognized that there may be opportunities to deliver renewable energy at lower cost.[15] To better understand the magnitude of the transmission costs, stakeholders requested that a sensitivity case be run that would eliminate the out-of-state portion of the costs. It is recognized that it is not realistic to assume zero costs for transmission. Therefore it should be understood that this sensitivity was largely performed for information purposes.

To perform this assessment, the following steps were taken:

- The out-of-state portion of the transmission cost (from the source CREZ to the California gateway CREZ) was eliminated
- In-state transmission costs were still accounted for as normal.
- In-state and out-of-state electrical losses on a percentage basis were accounted for as normal. However, the cost of losses is calculated based on the total of the generation plus transmission costs; therefore, to the extent transmission costs decrease, the cost of losses also decreases.

Figure 7-6 shows the original supply curve from Figure 7-1 (green) with an alternate supply curve (red) removing out-of-state transmission costs. The red supply curve is the original curve less the out-of-state transmission. The difference between the two is the out-of-state transmission cost for each resource. For example, the out-of-state transmission cost for the NV_NO CREZ is $10/MWh, NM_EA is $49/MWh, and BC_NW is $81/MWh. British Columbia resources areas are the furthest away of all resources studied in this project. There are opportunities to reduce these transmission costs, as demonstrated in the next section.

7.4.4 Sensitivity Analysis – Firmed and Shaped British Columbia Resource

As discussed previously, there are numerous opportunities to improve the economics of transmission for out-of-state resources. One of these is to develop energy products where intermittent resources such as wind are "firmed" and "shaped". Such products would be a mix of multiple resources whose output profiles complement each other to create a predictable, higher capacity factor product. Firmed and shaped products may be considered more valuable since they would likely have higher capacity value, may be more easily forecast and scheduled, would likely better utilize transmission, and may incur less integration cost than intermittent renewable resources.[16]

[15] Methods to lower transmission cost include: use of existing transmission, better financing, shaping and firming resources, use of more cost effective transmission technologies (e.g., HVDC).

[16] With the exception of capacity value and transmission utilization, RETI has not assigned a value to these benefits to date.

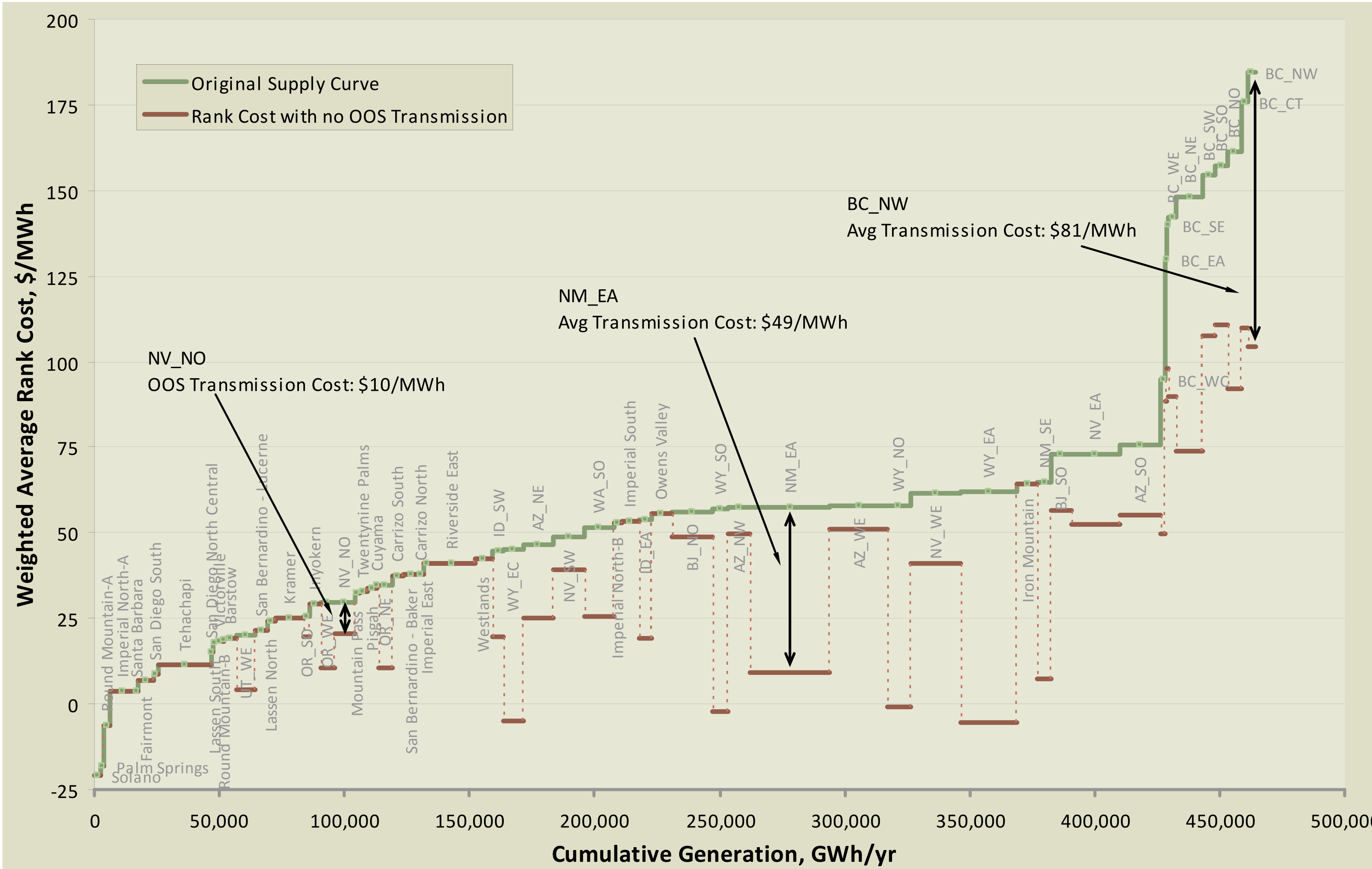


Figure 7-6. Impact of Removal of Out-of-state Transmission Costs.

Consideration of firmed and shaped resources was not part of the Phase 2B scope. However, considering the potential advantages of such products, it was determined that it would be valuable to perform a case study of one such proposal from British Columbia (BC). As part of the Western Renewable Energy Zones project, representatives from BC Hydro characterized a shaped renewable energy product available at the British Columbia-Washington border. The characteristics for this resource were updated for this report based on input from BC Hydro. BC Hydro provided the following characteristics for the firmed and shaped product:

- The product would be about half wind and the other half from small hydro or a mixture of small hydro, biomass and geothermal.
- Output of 1500 MW on a 7x24 schedule from April 1 to September 30
- Output of 850 MW on a 7x24 schedule from October1 to March 31
- Annual energy available: about 10,300 GWh
- About 78 percent annual transmission utilization factor
- Indicative pricing of $111/MWh CDN levelized for a 10-20 year term. Based on exchange rates prevalent in March 2010, this is about $109/MWh USD. BC Hydro has indicated that this is not intended to be a firm offer. Rather, it is a high-level pre-screening estimate.
- The price includes the cost to integrate and firm the resource and deliver it to the BC-US border.[17]

Based on the characteristics described above, Black & Veatch ran two special cases to understand the potential economic implications of this product:

- Figure 7-7 compares a BC shaped resource to the reference case assumptions (the original supply curve from Figure 7-1). The shaped product is significantly lower cost than individual BC CREZs due to higher transmission utilization and higher capacity value. In addition, it is likely that this product picks from the lowest cost renewable resources across all of BC, whereas the standard BC CREZs average their CREZ resources together.
- Figure 7-8 compares a BC shaped resource to the sensitivity case with no tax credits. Because Canadian (and Mexican) resources do not receive U.S. tax credits, they benefit when the tax credits are not available for U.S. projects. Under this scenario a BC shaped product is competitive with the top ranked CREZs (as are Baja North wind projects).

[17] Personal communication with Kathy Lee, BC Hydro, February-March 2010. BC Hydro's intent is to illustrate the benefits of a shaped and firmed, low carbon energy product and to encourage further discussion. Additional shaped products are also available.

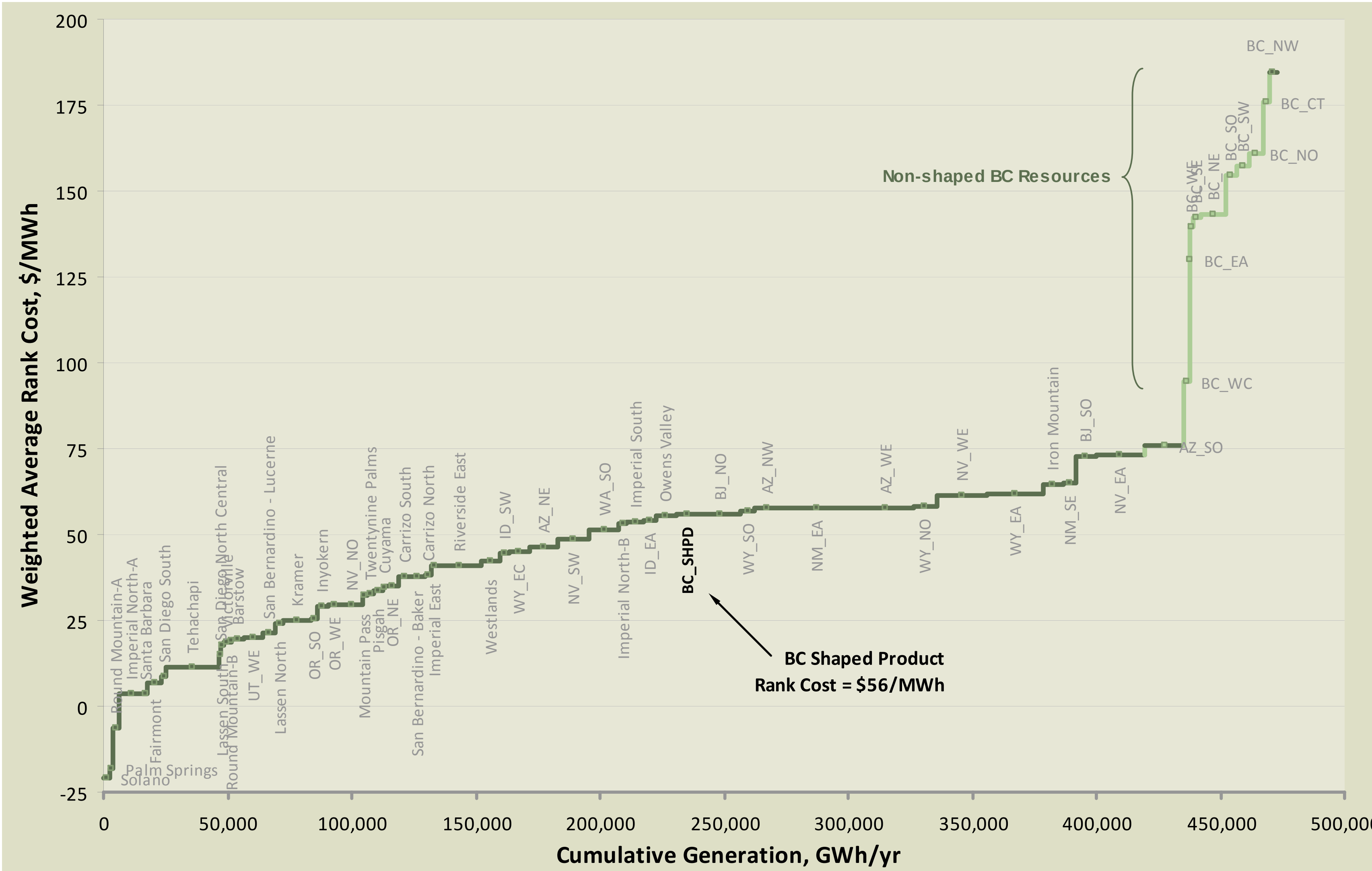


Figure 7-7. BC Shaped Resource Compared to Reference Case Assumptions.

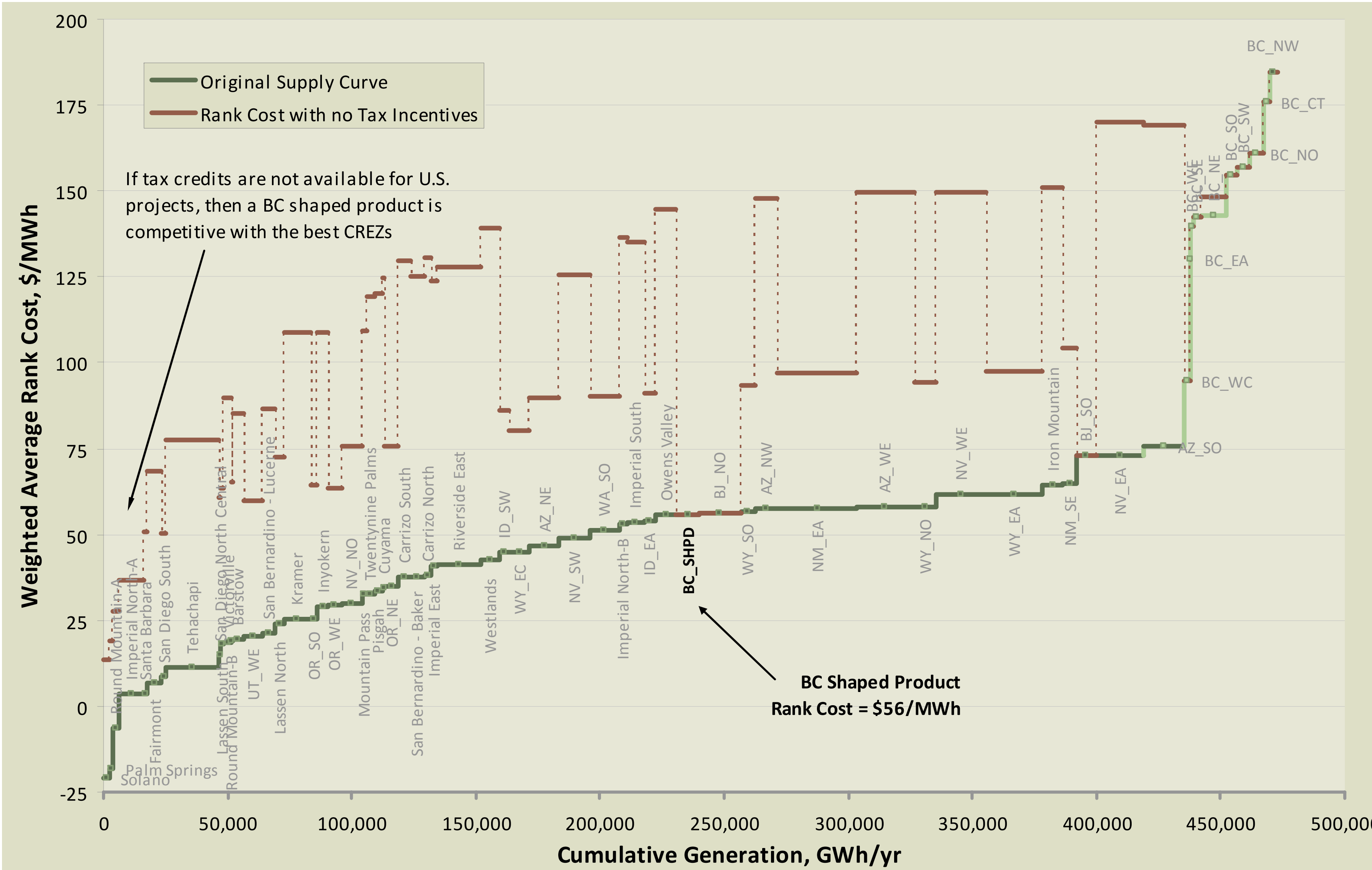


Figure 7-8. BC Shaped Resource Compared to Other Resources Without Tax Credits.

The intent of this exercise is not to specifically promote BC resources as more compelling than other resources. Other regions, including OR, WA, and ID, can likely offer similar shaped products. Rather, the purpose is to show the potential benefits that firming and shaping may provide. From this analysis it appears that these services may reduce the cost of out-of-state resources and provide additional benefits. Black & Veatch recommends that such products be further considered in future phases of RETI work.

7.4.5 Sensitivity Analysis – Advanced Solar Thermal Technologies

Solar comprises the largest share of renewable energy potential in California. Technology developers continue to innovate and advance technologies; evidence of this is the recent substantial declines in the cost of solar photovoltaics.[18] RETI assumed dry-cooled parabolic trough technology without storage as the proxy technology for characterizing solar thermal resources. There are numerous advanced solar thermal technologies that could improve on the economic and environmental characteristics of parabolic trough technology. However, to date, costs declines for solar thermal technologies have not been modeled by RETI. In Phase 1 of RETI, stakeholders agreed to not predict changes in technology cost over time. However, several other studies, including work by Black & Veatch, have forecast improvements in solar thermal technology that could lead to lower costs. This sensitivity study explores how reduction in costs for solar thermal could impact the RETI results.

Solar thermal is one of three solar technologies in RETI that can be modeled at a given location. In the base case reference runs for RETI, thin film solar photovoltaic has a lower rank cost than solar thermal. Since all of the solar technologies "compete" in the RETI model for the same site, thin film is chosen for 93 percent of sites, and tracking crystalline for 7 percent of sites. No solar thermal is chosen for development. To perform this assessment, the following steps were taken:

- The capital cost for solar thermal projects (base: $5,300/kW) was gradually reduced.[19]
- The mix of most economic solar technologies was evaluated
- Impacts on CREZ rankings were quantified at 30 and 45 percent capital cost reduction.

[18] The RETI Phase 1B report had relatively high costs ($7,000/kW) for tracking crystalline photovoltaics; these have since been reduced to around $4,500/kW for this report. RETI Phase 1 also only considered thin film technology as a sensitivity case. Thin film has since been adopted by RETI as a commercial technology, with a base cost of around $3,800/kW. Thus RETI has already recognized a large drop in solar PV costs, but has not considered potential declines for solar thermal.

[19] In reality improvements in multiple attributes besides capital cost are likely as technology advances. For example, capacity factor could increase with the addition of storage. For simplicity, however, reduction in capital cost was modeled as the key variable.

Figure 7-9 shows the impact of declines in solar thermal capital cost. As the cost of solar thermal declines, it becomes more economic than thin film and tracking crystalline technology. If solar thermal could drop costs about 32 percent from the base assumption of $5,300/kW to $3,600/kW, it would be the most cost effective solar technology for about 90 percent of the RETI sites. It is important to note that this sensitivity assumes that other technologies' economics are static, which may not be the case.

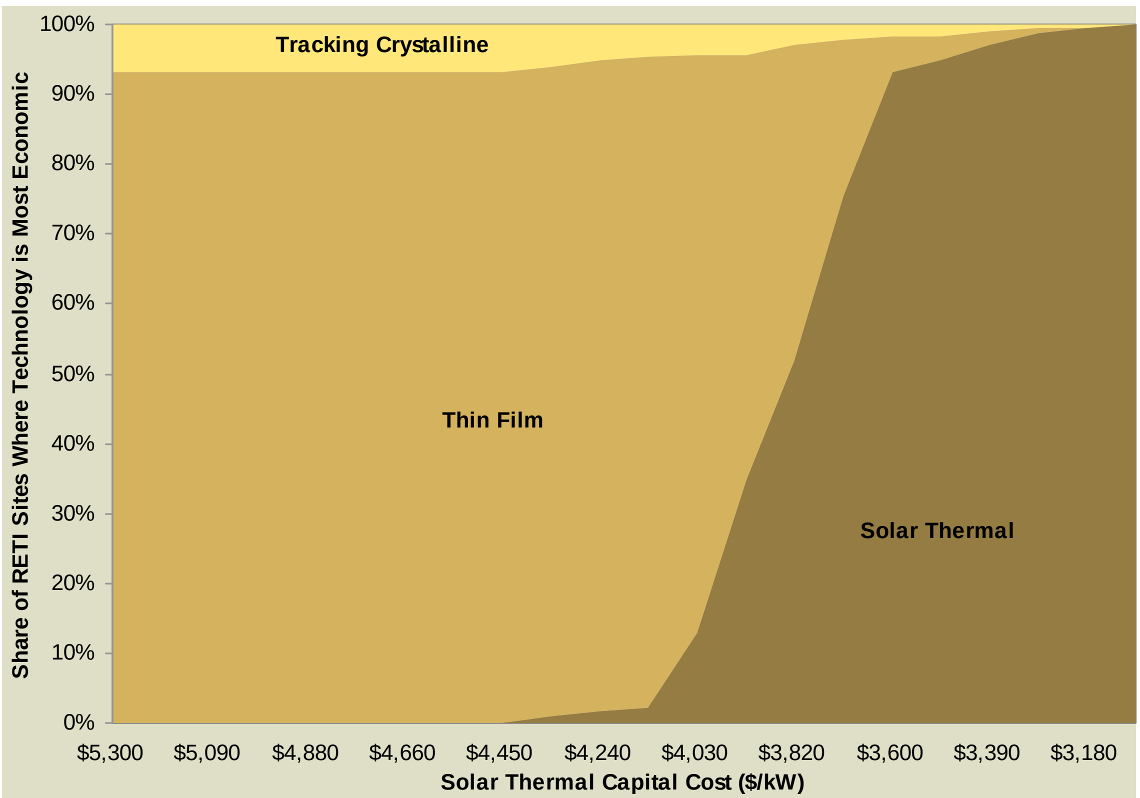


Figure 7-9. Most Economic Solar Technology as Solar Thermal Capital Cost Declines.

A significant finding of Figure 7-9 is that the economic shift from one technology to another can occur over a fairly small cost range. Considering the model sensitivity and the range of uncertainty previously discussed, it is important to stress that the RETI process should not be seen as finding that any single solar technology is more attractive than another. To reinforce this point, Figure 7-10 shows that the RETI results are fairly indifferent to a 30 percent reduction in solar thermal costs. This is because solar thermal displaces other solar technologies as its costs drop. It would not cause substantive changes in CREZ rankings unless costs dropped significantly more than 30 percent. This is shown in Figure 7-11, where the capital costs of solar thermal have been reduced by 45 percent. In such a scenario, CREZs with a high share of solar benefit the most (e.g. Kramer).

7.4.6 Sensitivity Analysis – Distributed Solar Photovoltaics

Distributed solar photovoltaic systems are an important consideration since they may have the potential to add renewable generation without the need for transmission system upgrades. As part of the net short calculation, RETI has assumed full deployment of smaller-scale solar PV systems (e.g., rooftop) in-line with California's goals. RETI has also considered larger systems, known as wholesale distributed generation, which would export power to the distribution system. These were first described in RETI Phase 1B. In RETI Phase 1B they did not affect the base case results, but did affect the results of a sensitivity study (the "Reduced Solar Photovoltaic Costs (Thin Film)"sensitivity).[20]

In RETI Phase 1, thin film solar was not included as a fully commercial technology. However, stakeholders recognized its promise, and for this reason a sensitivity study was performed to see what would happen if the technology became established, and costs dropped similar to manufacturers' projections. A capital cost of $3,700/kW was used as the basis for the original sensitivity study. RETI Phase 2 has since included thin film photovoltaic as a commercial technology with costs in the range of $3,600-$4,000/kW.

In addition to benefiting solar in CREZs, the results of the RETI Phase 1 sensitivity study showed that a large number of distributed 20 MW solar PV projects throughout the state might be economic – with important caveats. These 20 MW solar PV projects had been identified by assuming that each project could connect to a 69 or 115 kV substation with no transmission costs other than the cost to interconnect. In reality, some of the 69 or 115 kV substations would need upgrades to accept 20 MW of generating capacity. In fact, utilities have expressed concern that many of their substations would not be able to easily accommodate these PV projects at low cost. The original sensitivity was described as a test case, and it is not a realistic simulation of how large scale distributed solar development might occur. Additional investigation is needed to determine how much solar could be connected to the distribution system with minimal upgrade costs.

[20] For background, it is useful to refer to the original sensitivity study starting on pdf page 158 of the Final Phase 1B Report: http://www.energy.ca.gov/2008publications/RETI-1000-2008-003/RETI-1000-2008-003-F.PDF.

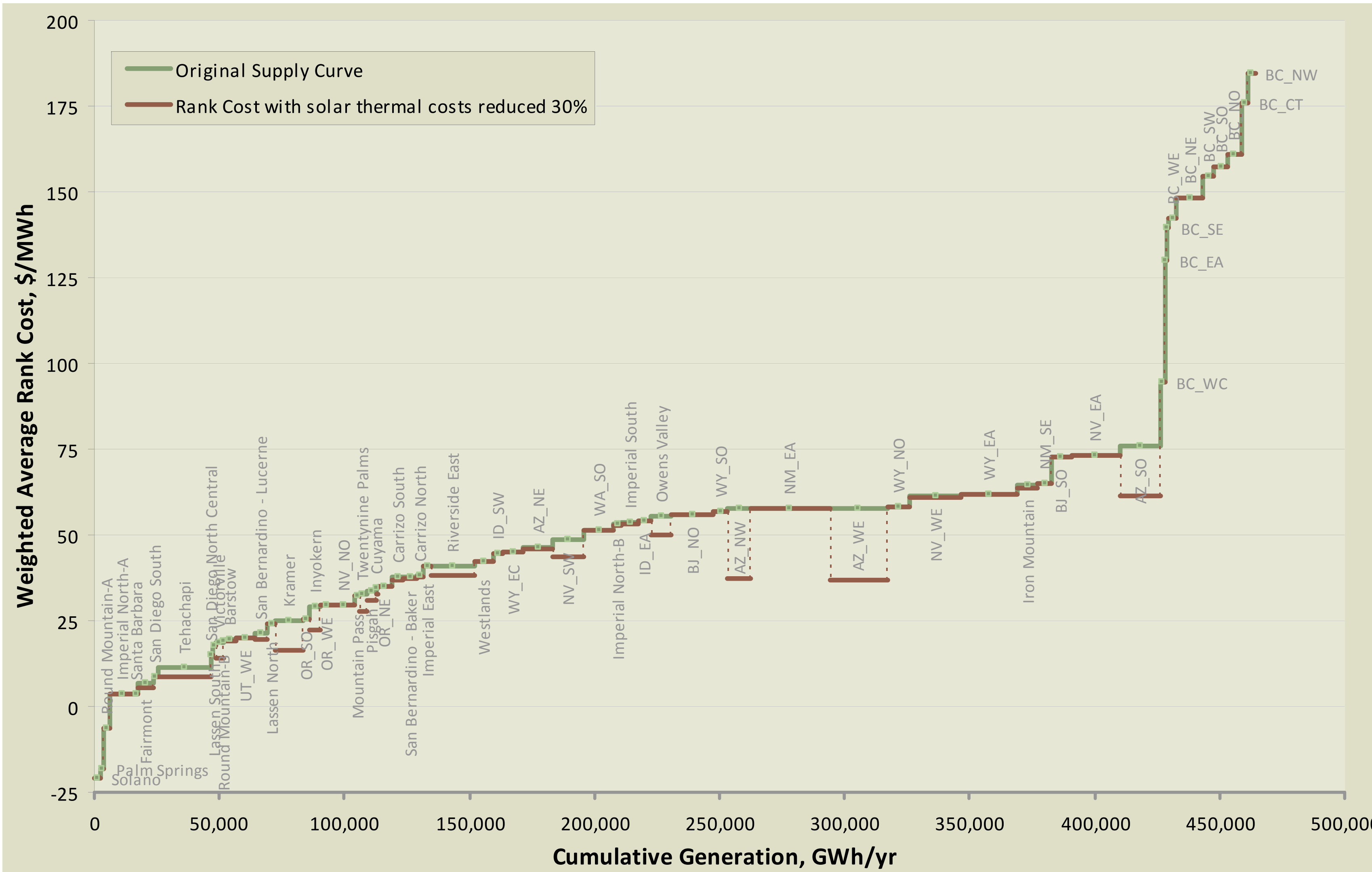


Figure 7-10. Impact of Reducing Solar Thermal Capital Costs 30 Percent.

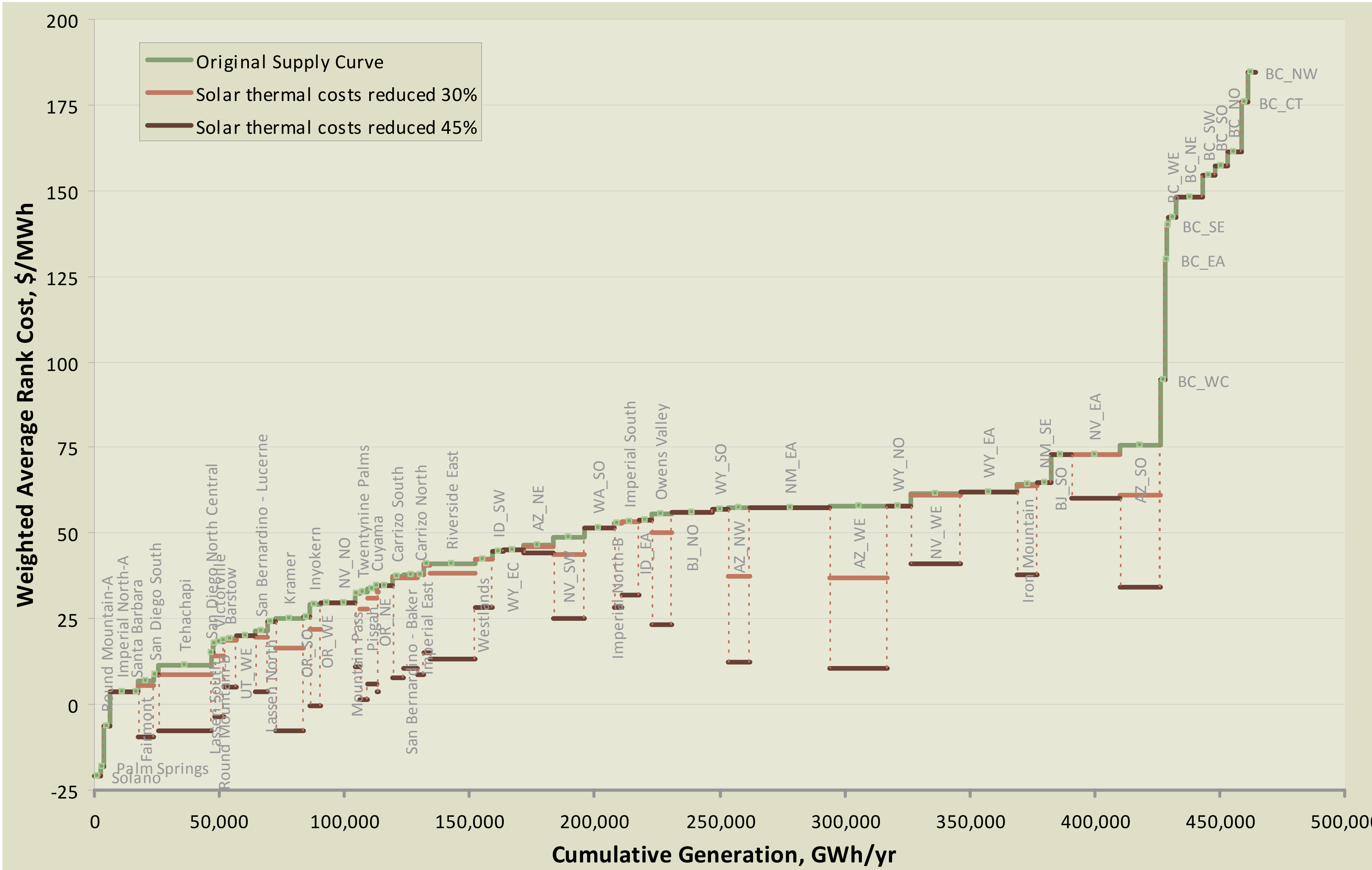


Figure 7-11. Impact of Reducing Solar Thermal Capital Costs 45 Percent.

Since RETI Phase 1, the CPUC has established the Renewable Distributed Energy Collaborative (Re-DEC) to help further explore the potential for wholesale distributed generation solar and other renewables.[21] Re-DEC poses the question: what challenges would be faced if 15,000 MW of distributed renewables were deployed over the next 10 years in California? Re-DEC is cataloging many of the potential challenges which may arise from such a scenario and is developing a workplan to address them in the near-term. It is likely that an updated assessment of the potential for wholesale distributed solar will be completed as part of Re-DEC or the CPUC's Long-Term Procurement Plan (LTPP) proceeding. In the meantime, the potential economic competitiveness of distributed solar can be assessed using the metrics established for the RETI Phase 2B. Because the interconnection and transmission costs are not known at this time, to complete this assessment a set of "best case" assumptions was made, as follows:

- Economies of Scale. 20 MW projects located on greenfield (i.e., not rooftop) sites were assumed. It was assumed that 20 MW projects would achieve the same economies-of-scale of the larger 150 MW solar PV projects. Thin film solar was assumed with a base cost of $3,800/kW.
- Minimal interconnection cost. Only the cost for cost for the interconnection line and associated interconnection equipment was included.
- No transmission cost. No additional transmission costs were included, even though some of these projects are located within CREZs and would presumably require the same upgrades as CREZs.
- No transmission losses were assumed.
- Full energy and capacity value. Energy and capacity values were calculated in a manner similar to larger projects. Currently projects that interconnect under the Small Generator Interconnection Procedures (SGIP) do not receive resource adequacy (capacity) credit. This is currently under review at the CAISO. For the purposes of a "best case" evaluation, it was assumed that the smaller systems would receive full capacity credit.

It is recognized that the above represents an idealized and optimistic set of assumptions that favor the economics of distributed solar PV. For this reason, this scenario should be viewed as a "best case" representation of potential solar PV economics. Actual costs will likely be higher except in the most favorable of locations. Additional investigation is required to determine how much solar could actually be installed under these ideal conditions, and how much additional cost would be necessary for other locations.

[21] For an overview see: http://www.cpuc.ca.gov/PUC/energy/Renewables/Re-DEC.htm.

RETI Phase 1 identified 1375 potential 20 MW solar PV sites (27,500 MW). Figure 7-12 shows a rank-ordered list of these sites applying the assumptions listed above.[22] The lowest cost sites generally have a rank cost between \$10/MWh and \$20/MWh under the "best case" assumptions. This range can be compared to Table 7-3, which shows the base case results for the best CREZs up to \$30/MWh. This indicates that there is potential for distributed solar to compete with the larger CREZ resources. However, the key question is how much is available under the "best case" assumptions. As discussed earlier, this potential should be better assessed through the Re-DEC project or the CPUC's LTPP proceeding.

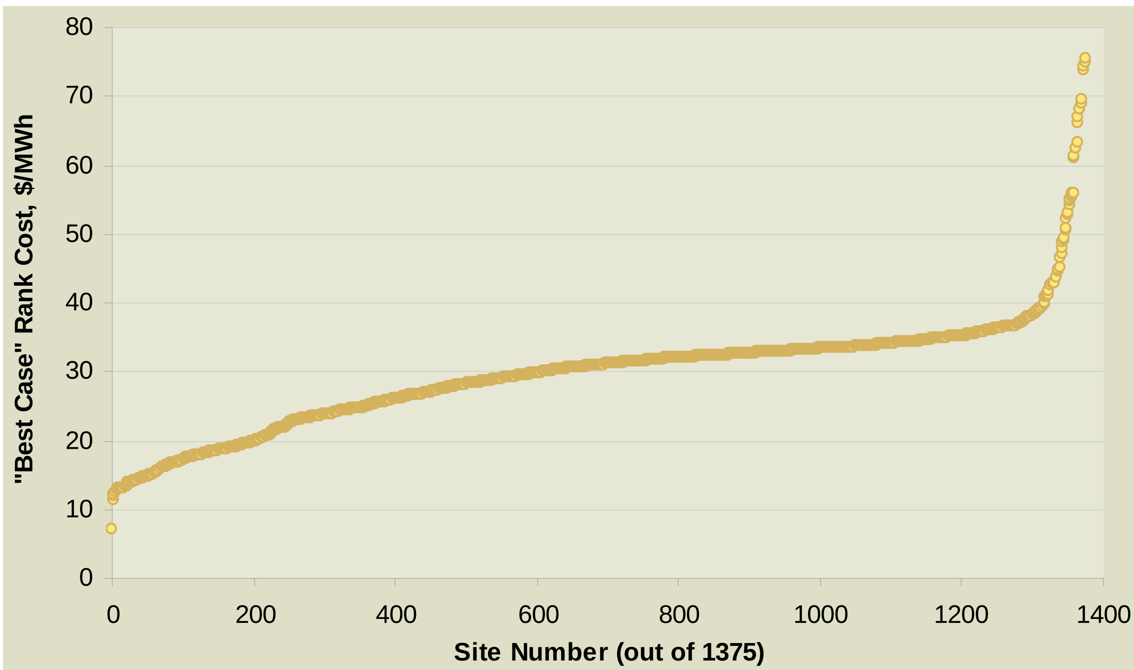


Figure 7-12. Ranked List of Distributed Solar PV Sites.

7.5 CREZ Environmental Rankings

The environmental work group is in the processing of reviewing the methodology and the environmental scores for CREZs. More information about this will be included in the final Phase 2B report. The current environmental scores are shown in the table below.

[22] Note that the potential supply in MW or GWh/yr is not shown on the chart because it is not appropriate to assume that all of the sites could be fully developed to accommodate 20 MW while still assuming negligible interconnection and transmission cost. Further analysis is needed to assess the quantity available at various cost points. *If* every site could be developed at a full 20 MW, then the x-axis would go to 27,500 MW.

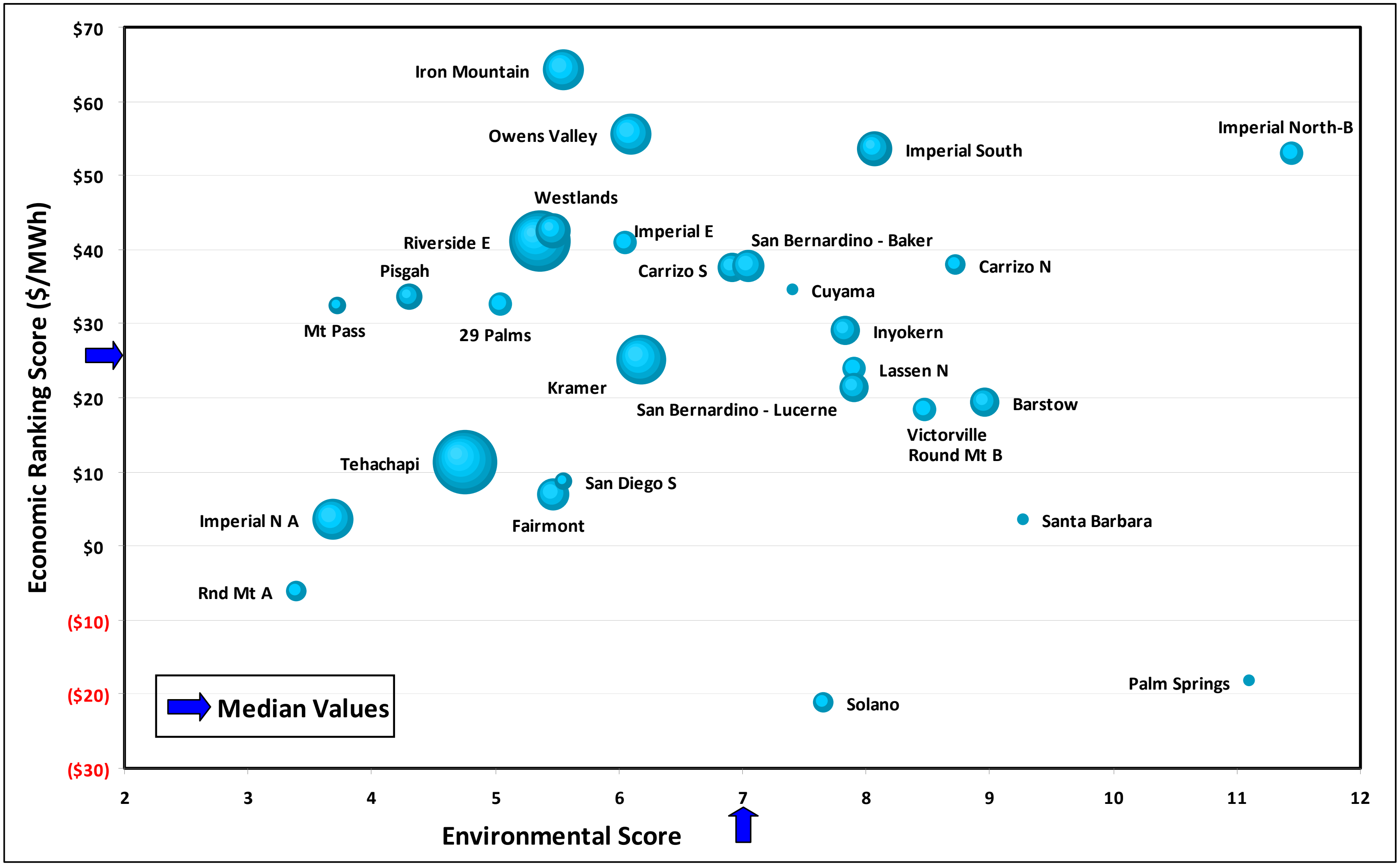
Table 7-6. California CREZ Environmental Scores.

CREZ	Environmental Score
Round Mountain-A	3.4
Imperial North-A	3.7
Mountain Pass	3.7
Pisgah-A	4.3
Tehachapi	4.8
Twentynine Palms	5.0
Riverside East	5.4
Fairmont	5.5
Westlands	5.5
Iron Mountain	5.5
San Diego South	5.6
Imperial East	6.1
Owens Valley	6.1
Kramer	6.2
Carrizo South	6.9
San Bernardino - Baker	7.0
Cuyama	7.4
Solano	7.7
Inyokern	7.8
Lassen North	7.9
San Bernardino - Lucerne	7.9
Imperial South	8.1
Victorville	8.5
Round Mountain-B	8.5
Carrizo North	8.7
Barstow	9.0
Santa Barbara	9.3
Palm Springs	11.1
Imperial North-B	11.4
Lassen South	19.5
San Diego North Central	22.3

7.6 Combined Environmental and Economic Ranking

Black & Veatch re-ranked the CREZ using the same process as outlined in Phase 1B of RETI. The economic scores identified in this section were used for the updated economic ranks. Based on the new CREZ descriptions, updated environmental scores were calculated employing the same process described in the Phase 1B Report.

The bubble chart below in Figure 7-13 shows revised CREZ assessments in terms of relative economic cost and environmental concerns per unit energy produced. As in the Phase 1B Report, CREZ to the left in this chart are expected to have fewer environmental concerns per unit energy production, and CREZ toward the bottom are expected to have lower cost/higher economic value per unit energy. Since comparable environmental data is not available, out-of-state areas are not shown on this chart. Figure 7-14 shows how these scores compared to scores from Phase 1B.



Notes:

- Areas of the bubbles are proportional to CREZ energy.
- Lassen South CREZ is off the right side of the chart. (Economic Score = 18, Environmental Score = 19.50, Energy = 1051 GWh)
- San Diego North Central CREZ is off the right side of the chart. (Economic Score = 15, Environmental Score = 22.3, Energy = 502 GWh)
- Victorville and Round Mountain-B are coincident

Figure 7-13. CREZ Economic and Environmental Scores Phase 2B, Bubble Chart.

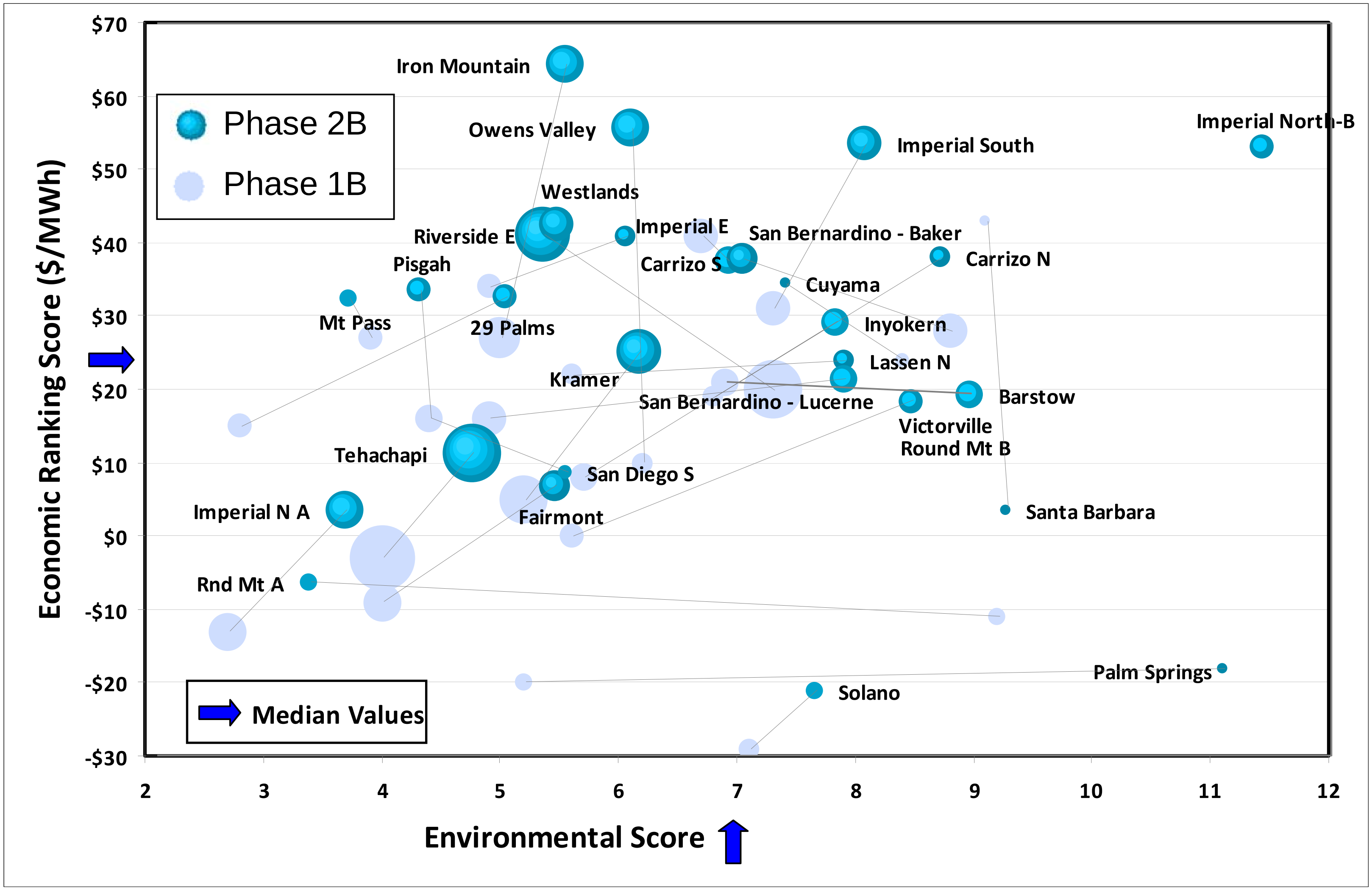


Figure 7-14. Comparison of Combined Economic and Environmental Ranking between Phase 2B and 1B.