Client Name
RETI Stakeholder Steering Committee

B&V Project
149148

Project Name
RETI Phase 1B – Economic Analysis of CREZ

Version
Final Report Revised XXX

Publish Date
26 January 2009

Black & Veatch Corporation · 11401 Lamar · Overland Park, KS 66211 USA · Telephone: 913.458.2000

RETI Stakeholder Steering Committee

Renewable Energy Transmission Initiative

RETI Phase 1B – Economic Analysis of Competitive Renewable Energy Zones

FINAL REPORT REVISED XXX~~FINAL REPORT~~

B&V Project Number 149148

REVISED XXXXX

Contract Manager

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

January 2009

Black & Veatch Corporation
2999 Oak Rd, Suite 490
Walnut Creek, CA 94597
Tel: (913) 458-2000 www.bv.com

BLACK & VEATCH
Building a world of difference.

Black & Veatch Principal Investigators:

Ryan Pletka, Project Manager
Steve Arndt
Steve Block
Derek Djeu
Josh Finn
Seema Ghosh
Adam Hanna
Cristin Holmgren
Kevin Joyce
Tim Mason
Dennis Noll
Ric O’Connell
Scott Olson
Andy Rawlins
Larry Stoddard

GeothermEx – Subcontractor for geothermal sections

Table of Contents

1.0 Summary 1-1
1.1 Identification and Ranking of Competitive Renewable Energy Zones and Resource Areas 1-1
1.2 California CREZ Economic Rank Cost and Supply Curve 1-3
1.3 Economics of Out-of-State Resources 1-8
1.4 Economics of Non-CREZ Resources 1-8
1.5 Uncertainty and Sensitivity Analysis 1-9
1.6 Summary of Renewable Energy Resources 1-12
1.7 Use and Purpose of this Report 1-13
1.8 Recommended Phase 2 Issues 1-13
1.8.1 Transmission Methodology 1-13
1.8.2 Capacity Costs and Integration Costs 1-14
1.8.3 Baja California Norte Wind Resources 1-15
1.8.4 Project Identification Limitations 1-15

2.0 Introduction 2-1
2.1 Background 2-1
2.2 Approach 2-2
2.3 Report Organization 2-2
2.4 Accompanying Maps 2-2

3.0 Methodology and Assumptions 3-1
3.1 Project Identification & CREZ Development Process 3-1
3.1.1 Project Identification and Characterization 3-1
3.1.2 CREZ Development 3-2
3.2 Exclusion Areas 3-2
3.2.1 Environmental, Cultural and Land Use Exclusions 3-5
3.2.2 Military Exclusions 3-5
3.2.3 Other Exclusions 3-5
3.2.4 Resource Specific Exclusion Zones 3-6
3.2.5 Limitations of the Project Identification Process 3-6
3.3 Pre-Identified Projects 3-7
3.3.1 Generator Data Request 3-8
3.3.2 Department of Defense Lands Proposed Development 3-8
3.3.3 Bureau of Land Management Land Leases 3-9
3.3.4 Utility Power Purchase Agreements 3-10

3.3.5 Transmission Operator Interconnection Queues 3-10
3.4 Out-of-state Resources 3-11
3.5 Transmission 3-14
3.5.1 Methodology 3-14
3.5.2 California Transmission 3-16
3.5.3 Out-of-State Transmission 3-19
3.5.4 South Out-of-State Resource Areas (AZ and Baja, Mexico) 3-22
3.6 Resource Valuation 3-22
3.6.1 Generation Cost 3-22
3.6.2 Transmission Costs 3-26
3.6.3 Energy Value 3-27
3.6.4 Capacity Value 3-30
3.6.5 Ranking Cost 3-32
3.6.6 Consideration of Uncertainty and Sensitivities 3-32
3.7 Development Timeframe 3-32
3.8 Net Short Calculation 3-35
3.8.1 California Load Growth 3-36
3.8.2 RPS Assumptions 3-36
3.8.3 Existing Resources 3-37
3.8.4 Under Construction and Pre-Construction Resources 3-38
3.8.5 Go Solar California Program 3-39
3.8.6 Contribution of Other Renewables 3-40
3.8.7 RETI Net Short 3-41

4.0 4-1

~~1.0 Summary 1-1~~
~~1.1 Identification and Ranking of Competitive Renewable Energy Zones and Resource Areas 1-1~~
~~1.2 California CREZ Economic Rank Cost and Supply Curve 1-3~~
~~1.3 Economics of Out-of-State Resources 1-8~~
~~1.4 Economics of Non-CREZ Resources 1-8~~
~~1.5 Uncertainty and Sensitivity Analysis 1-9~~
~~1.6 Summary of Renewable Energy Resources 1-12~~
~~1.7 Use and Purpose of this Report 1-13~~
~~1.8 Recommended Phase 2 Issues 1-13~~
~~1.8.1 Transmission Methodology 1-13~~
~~1.8.2 Capacity Costs and Integration Costs 1-14~~

~~1.8.3 Baja California Norte Wind Resources .... 1-15~~
~~1.8.4 Project Identification Limitations .... 1-15~~

~~2.0 Introduction .... 2-1~~
~~2.1 Background .... 2-1~~
~~2.2 Approach .... 2-2~~
~~2.3 Report Organization .... 2-2~~
~~2.4 Accompanying Maps .... 2-2~~

~~3.0 Methodology and Assumptions .... 3-1~~
~~3.1 Project Identification & CREZ Development Process .... 3-1~~
~~3.1.1 Project Identification and Characterization .... 3-1~~
~~3.1.2 CREZ Development .... 3-2~~
~~3.2 Exclusion Areas .... 3-2~~
~~3.2.1 Environmental, Cultural and Land Use Exclusions .... 3-5~~
~~3.2.2 Military Exclusions .... 3-5~~
~~3.2.3 Other Exclusions .... 3-5~~
~~3.2.4 Resource Specific Exclusion Zones .... 3-6~~
~~3.2.5 Limitations of the Project Identification Process .... 3-6~~
~~3.3 Pre-Identified Projects .... 3-7~~
~~3.3.1 Generator Data Request .... 3-8~~
~~3.3.2 Department of Defense Lands Proposed Development .... 3-8~~
~~3.3.3 Bureau of Land Management Land Leases .... 3-9~~
~~3.3.4 Utility Power Purchase Agreements .... 3-10~~
~~3.3.5 Transmission Operator Interconnection Queues .... 3-10~~
~~3.4 Out-of-state Resources .... 3-11~~
~~3.5 Transmission .... 3-14~~
~~3.5.1 Methodology .... 3-14~~
~~3.5.2 California Transmission .... 3-16~~
~~3.5.3 Out-of-State Transmission .... 3-19~~
~~3.5.4 South Out-of-State Resource Areas (AZ and Baja, Mexico) .... 3-22~~
~~3.6 Resource Valuation .... 3-22~~
~~3.6.1 Generation Cost .... 3-22~~
~~3.6.2 Transmission Costs .... 3-26~~
~~3.6.3 Energy Value .... 3-27~~
~~3.6.4 Capacity Value .... 3-30~~
~~3.6.5 Ranking Cost .... 3-32~~
~~3.6.6 Consideration of Uncertainty and Sensitivities .... 3-32~~

~~3.7 Development Timeframe .... 3-32~~
~~3.8 Net Short Calculation .... 3-35~~
~~3.8.1 California Load Growth .... 3-35~~
~~3.8.2 RPS Assumptions .... 3-36~~
~~3.8.3 Existing Resources .... 3-37~~
~~3.8.4 Under Construction and Pre-Construction Resources .... 3-37~~
~~3.8.5 California Solar Initiative .... 3-38~~
~~3.8.6 Contribution of Other Renewables .... 3-39~~
~~3.8.7 RETI Net Short .... 3-40~~

~~4.0 Competitive Renewable Energy Zones and Resource Areas**Error! Bookmark not defined.**4-1~~
~~4.1 California Resource Areas .... 4-1~~
~~4.1.1 Central Coast .... 4-1~~
~~4.1.2 Salton Sea / San Diego .... 4-4~~
~~4.1.3 Northern California .... 4-7~~
~~4.1.4 Tehachapi / Owens .... 4-10~~
~~4.1.5 Southeast California .... 4-13~~
~~4.1.6 Percent of Proxy Projects Identified in CREZs .... 4-18~~
~~4.2 Out-of-State Resource Areas .... 4-20~~
~~4.2.1 North Out-of-State .... 4-20~~
~~4.2.2 Nevada .... 4-25~~
~~4.2.3 Southern Out-of-State .... 4-29~~

~~5.0 CREZ Economic Analyses .... 5-1~~
~~5.1 CREZ Rank Costs .... 5-1~~
~~5.2 Resource Supply Curves .... 5-4~~
~~5.3 CREZ and Resource Area Supply Curves .... 5-6~~
~~5.4 Sub-CREZ Identification .... 5-7~~
~~5.5 Out-of-State Resources .... 5-10~~
~~5.6 Non-CREZ Resources .... 5-11~~
~~5.7 Results – Top Ranked CREZs .... 5-12~~
~~5.7.1 Results Including Transmission Capital Cost .... 5-12~~
~~5.7.2 Results without Transmission Capital Cost .... 5-14~~
~~5.8 Uncertainty and Sensitivity Analyses .... 5-18~~
~~5.8.1 Uncertainty Assessment .... 5-19~~
~~5.8.2 Sensitivity Analysis – Elimination of Tax Credits .... 5-23~~
~~5.8.3 Sensitivity Analysis – Energy Value .... 5-25~~
~~5.8.4 Reduced Capacity Value .... 5-27~~

~~5.8.5 Reduced Solar Photovoltaic Costs (Thin Film) .... 5-27~~
~~5.8.6 Expanded Geothermal Potential .... 5-31~~
~~5.8.7 Full Allocation of Transmission Costs .... 5-32~~
~~5.8.8 Uncertainty and Sensitivity Analysis Conclusions .... 5-33~~

~~6.0 Project Identification and Characterization .... 6-1~~
~~6.1 Biomass .... 6-1~~
~~6.1.1 Project Identification Approach .... 6-1~~
~~6.1.2 Project Characterization Assumptions .... 6-4~~
~~6.1.3 Data Sources .... 6-5~~
~~6.1.4 Projects Identified .... 6-5~~
~~6.1.5 California Executive Order S-06-06 .... 6-6~~
~~6.2 Geothermal .... 6-8~~
~~6.2.1 Project Identification Approach .... 6-8~~
~~6.2.2 Project Characterization Assumptions .... 6-9~~
~~6.2.3 Data Sources .... 6-11~~
~~6.2.4 Projects Identified .... 6-11~~
~~6.3 Solar Thermal .... 6-13~~
~~6.3.1 Project Identification Approach .... 6-13~~
~~6.3.2 Project Characterization Assumptions .... 6-15~~
~~6.3.3 Data Sources .... 6-16~~
~~6.3.4 Projects Identified .... 6-16~~
~~6.4 Solar Photovoltaic .... 6-18~~
~~6.4.1 Project Identification Approach .... 6-18~~
~~6.4.2 Project Characterization Assumptions .... 6-21~~
~~6.4.3 Data Sources .... 6-24~~
~~6.4.4 Projects Identified .... 6-25~~
~~6.5 Wind .... 6-26~~
~~6.5.1 Project Identification Approach .... 6-26~~
~~6.5.2 Project Characterization Assumptions .... 6-32~~
~~6.5.3 Output Profile .... 6-33~~
~~6.5.4 Data Sources .... 6-35~~
~~6.5.5 Projects Identified .... 6-35~~

Appendices

Appendix A. U.S. Bureau of Land Management Lease Applications

Appendix B. Utility Power Purchase Agreements

Appendix C. Transmission Owner Interconnection Queue

Appendix D. Project Characterisitcs

Appendix E. Supply Curves

List of Tables

Table 1-1. Weighted Average CREZ Rank Costs. 1-4
Table 1-2. Base Case Cost-Competitive Out-of-State Resources.................................. 1-8
Table 1-3. RETI Resource Summary by Resource Area 1-12
Table 3-1. Excluded Lands for RETI.. 3-3
Table 3-2. Pre-Identified Resources by Source and Resource Type (All locations) 3-7
Table 3-3. Pre-Identified Projects from Generator Data Request.................................. 3-8
Table 3-4. Pre-Identified Military Projects.. 3-9
Table 3-5. BLM Application Pre-Identified Projects (all locations). 3-10
Table 3-6. Utility Power Purchase Agreement Pre-Identified Projects. 3-10
Table 3-7. Generation Interconnection Queue Data Sources....................................... 3-11
Table 3-8. Resource Areas Studied in Phase 1B... 3-12
Table 3-9. British Columbia Resource Characteristics.. 3-14
Table 3-10. Approved Transmission 3-17
Table 3-11. Available Transfer Capability By CREZ 3-18
Table 3-12. Transmission Capital Cost - WECC Technical Advisory Committee 3-20
Table 3-13. Variable Transmission Costs 3-27
Table 3-14. Energy Forecast Gas Prices ($/MBtu).. 3-29
Table 3-15. Energy Forecast Assumptions 3-30
Table 3-16. Example Capacity Value Calculation... 3-31
Table 3-17. Baseline Capacity Value ($2007).. 3-32
Table 3-18. Resource Development Timeframe 3-33
Table 3-19. Development Timeframe by CREZ.. 3-34
Table 3-20. RPS Requirements... 3-36
Table 3-21. Existing RPS-Eligible Resources. 3-37
Table 3-22. RPS-Eligible Under Construction and Pre-Construction Resources.......... 3-38
Table 3-23. Go Solar California Expected Contribution to RPS 3-40
Table 3-24. Production Timescale and Energy Delivery for Other Renewables.......... 3-41
Table 3-25. RETI Net Short Calculations.. 3-42
~~Table 1-1. Weighted Average CREZ Rank Costs. .... 1-4~~
~~Table 1-2. Base Case Cost-Competitive Out-of-State Resources.................................. 1-8~~
~~Table 1-3. RETI Resource Summary by Resource Area .... 1-12~~
~~Table 3-1. Excluded Lands for RETI.. 3-3~~
~~Table 3-2. Pre-Identified Resources by Source and Resource Type (All locations) .... 3-7~~
~~Table 3-3. Pre-Identified Projects from Generator Data Request.................................. 3-8~~
~~Table 3-4. Pre-Identified Military Projects.. 3-9~~
~~Table 3-5. BLM Application Pre-Identified Projects (all locations). .... 3-10~~

~~Table 3-6. Utility Power Purchase Agreement Pre-Identified Projects. .... 3-10~~
~~Table 3-7. Generation Interconnection Queue Data Sources.. 3-11~~
~~Table 3-8. Resource Areas Studied in Phase 1B.. 3-12~~
~~Table 3-9. British Columbia Resource Characteristics.. 3-14~~
~~Table 3-10. Approved Transmission .... 3-17~~
~~Table 3-11. Available Transfer Capability By CREZ .... 3-18~~
~~Table 3-12. Transmission Capital Cost – WECC Technical Advisory Committee ..... 3-20~~
~~Table 3-13. Variable Transmission Costs.. 3-27~~
~~Table 3-14. Energy Forecast Gas Prices ($/MBtu).. 3-29~~
~~Table 3-15. Energy Forecast Assumptions.. 3-30~~
~~Table 3-16. Example Capacity Value Calculation... 3-31~~
~~Table 3-17. Baseline Capacity Value ($2007).. 3-32~~
~~Table 3-18. Resource Development Timeframe.. 3-33~~
~~Table 3-19. Development Timeframe by CREZ.. 3-34~~
~~Table 3-20. RPS Requirements... 3-36~~
~~Table 3-21. Existing RPS-Eligible Resources. .... 3-37~~
~~Table 3-22. RPS-Eligible Under Construction and Pre-Construction Resources.......... 3-38~~
~~Table 3-23. CSI Expected Contribution to RPS .... 3-39~~
~~Table 3-24. Production Timescale and Energy Delivery for Other Renewables.......... 3-40~~
~~Table 3-25. RETI Net Short Calculations... 3-41~~
~~Table 4-1. Central Coast Resource Summary by CREZ... 4-3~~
~~Table 4-2. Central Coast Economic Characteristics by CREZ.**Error! Bookmark not defined.**4-4~~
~~Table 4-3. Salton Sea / San Diego Resource Summary by CREZ.................................. 4-6~~
~~Table 4-4. Salton Sea / San Diego Economic Characteristics by CREZ. .... 4-7~~
~~Table 4-5. Northern California Resource Summary by CREZ...................................... 4-9~~
~~Table 4-6. Northern California Economic Characteristics by CREZ. .... 4-10~~
~~Table 4-7. Tehachapi / Owens Resource Summary by CREZ...................................... 4-12~~
~~Table 4-8. Tehachapi / Owens Economic Characteristics by CREZ. .... 4-13~~
~~Table 4-9. Southeast California Resource Summary by CREZ.................................... 4-16~~
~~Table 4-10. Southeast California Economic Characteristics by CREZ. .... 4-17~~
~~Table 4-11. Generation Potential from Proxy Projects... 4-19~~
~~Table 4-12. North Out-of-State Resource Summary by Resource Area....................... 4-24~~
~~Table 4-13. North Out-of-State Economic Characteristics by Resource Area. .... 4-25~~
~~Table 4-14. Nevada Resource Summary by Resource Area.. 4-28~~
~~Table 4-15. Nevada Economic Characteristics by Resource Area. .... 4-29~~
~~Table 4-16. Southwest Out-of-State Resource Summary by Resource Area. .... 4-32~~
~~Table 4-17. Southwest Out-of-State Economic Characteristics by Resource Area...... 4-33~~

~~Table 5-1. Weighted Average California CREZ Rank Costs. .... 5-2~~
~~Table 5-2. Weighted Average Rank Costs – All CREZ and Resource Areas. .... 5-3~~
~~Table 5-3. Cost-Competitive Out-of-State Resources. .... 5-10~~
~~Table 5-4. Competitive Non-CREZ Wind and Geothermal Projects. .... 5-12~~
~~Table 5-5. Economic Analysis Results – Base Case... 5-13~~
~~Table 5-6. Potential Ranges of Uncertainty for Major Resource Variables. .... 5-19~~
~~Table 5-7. Calculated Uncertainty Band for Typical Projects...................................... 5-20~~
~~Table 5-8. Resources Potentially Competitive Considering Uncertainty. .... 5-23~~
~~Table 5-9. Economic Analysis Results – No Tax Credit Sensitivity........................... 5-25~~
~~Table 5-10. Economic Analysis Results – Low Energy Prices. .... 5-26~~
~~Table 5-11. Economic Analysis Results – High Energy Prices.................................... 5-26~~
~~Table 5-12. Economic Analysis Results – Reduced Capacity Value Sensitivity. .... 5-27~~
~~Table 5-13. Economic Analysis Results – Reduced Solar Costs................................. 5-29~~
~~Table 5-14. Economic Analysis Results – Expanded Geothermal. .... 5-32~~
~~Table 5-15. Economic Analysis Results – Full Transmission Cost Allocation............ 5-33~~
~~Table 6-1. Delivered Biomass Resource Cost. .... 6-4~~
~~Table 6-2. Geothermal Project Totals by State (Net MW) .... 6-12~~
~~Table 6-3. Photovoltaics Cost Parameters. .... 6-24~~
~~Table 6-4. Turbines Considered for Average Power Curve Calculation...................... 6-27~~
~~Table 6-5. Calculated 'Typical Turbine' Used in Analysis.. 6-27~~
~~Table 6-6. Theoretical Baja Wind Resource (MW), Class 4 and higher...................... 6-32~~
~~Table 6-7. Out-of-state Wind Resources. .... 6-36~~

List of Figures

Figure 1-1. RETI Resource Area. 1-2
Figure 1-2. Weighted Average Rank Cost ($/MWh) for CREZ and Resource Areas.... 1-6
Figure 1-3. Impact of Removing Transmission Capital Cost from all Resources (in Ascending Order). 1-7
Figure 1-4. Effect of Reduced Solar Costs on CREZ Supply Curve. 1-11
Figure 2-1. Overview of RETI Phase 1 Methodology. 2-1
Figure 3-1. Project Identification & CREZ Development Process................................ 3-1
Figure 3-2. Example of Wind and Solar Thermal Exclusions Near Tehachapi.............. 3-4
Figure 3-3. Example Generation Cost Calculation for a Wind Project. 3-25
Figure 3-4. Energy Forecast Gas Prices ($/MBtu).. 3-29
Figure 3-5. Annual RPS Requirement. 3-37
Figure 3-6. RETI Net Short Calculation... 3-43
~~Figure 1-1. RETI Resource Area. .... 1-2~~

~~Figure 1-2. Weighted Average Rank Cost ($/MWh) for CREZ and Resource Areas.... 1-6~~
~~Figure 1-3. Impact of Removing Transmission Capital Cost from all Resources (in Ascending Order). .... 1-7~~
~~Figure 1-4. Effect of Reduced Solar Costs on CREZ Supply Curve. .... 1-11~~
~~Figure 2-1. Overview of RETI Phase 1 Methodology. .... 2-1~~
~~Figure 3-1. Project Identification & CREZ Development Process. .... 3-1~~
~~Figure 3-2. Example of Wind and Solar Thermal Exclusions Near Tehachapi. .... 3-4~~
~~Figure 3-3. Example Generation Cost Calculation for a Wind Project. .... 3-25~~
~~Figure 3-4. Energy Forecast Gas Prices ($/MBtu). .... 3-29~~
~~Figure 3-5. Annual RPS Requirement. .... 3-36~~
~~Figure 3-6. RETI Net Short Calculation .... 3-41~~
~~Figure 4-1. Central Coast Resource Area. .... 4-2~~
~~Figure 4-2. Salton Sea / San Diego Resource Area. ... **Error! Bookmark not defined.** 4-5~~
~~Figure 4-3. Northern California Resource Area. .... 4-8~~
~~Figure 4-4. Tehachapi / Owens Resource Area. .... 4-11~~
~~Figure 4-5. Southeast California Resource Area. .... 4-14~~
~~Figure 4-6. Twentynine Palms Planned Base Expansion (Blue Areas). .... 4-18~~
~~Figure 4-7. North Out-of-State Resource Areas. .... 4-22~~
~~Figure 4-8. Nevada Resource Area. .... 4-27~~
~~Figure 4-9. Southwest Out-of-State Resource Area. .... 4-31~~
~~Figure 5-1. Weighted Average Rank Cost (2009 $/MWh) for CREZs and Resource Areas. .... 5-5~~
~~Figure 5-2. Tehachapi Supply Curve. .... 5-7~~
~~Figure 5-3. Lassen North Supply Curve. .... 5-9~~
~~Figure 5-4. Impact of Removing Transmission Capital Cost from all Resources (in Original Order). .... 5-16~~
~~Figure 5-5. Impact of Removing Transmission Capital Cost from all Resources (in Ascending Order). .... 5-17~~
~~Figure 5-6. Supply Curve with Uncertainty Bands. .... 5-21~~
~~Figure 5-7. Effect of Reduced Solar Costs on CREZ Supply Curve. .... 5-30~~
~~Figure 6-1. Example Energy Output from Tracking Crystalline and Fixed Tilt Thin Film (July). .... 6-23~~
~~Figure 6-2. Example Energy Output from Tracking Crystalline and Fixed Tilt Thin Film (December). .... 6-23~~
~~Figure 6-3 Averaged WTG Power Curves. .... 6-27~~
~~Figure 6-4. Baja Wind Resources. .... 6-31~~
~~Figure 6-5 Wind Areas Studied by AWS Truewind. .... 6-34~~

Legal Notice

This report was prepared for University of California, Office of the President (The Regents) by Black & Veatch Corporation (Black & Veatch) and is based on information not within the control of The Regents or Black & Veatch. Neither The Regents nor Black & Veatch have made an analysis, verified, or rendered an independent judgment of the validity of the information provided by others. While it is believed that the information contained herein will be reliable under the conditions and subject to the limitations set forth herein, neither The Regents or Black & Veatch guarantee the accuracy thereof.

1.0 Summary

Black & Veatch is pleased to provide this Final Report on the Phase 1B activities of the California Renewable Energy Transmission Initiative (RETI) to the Stakeholder Steering Committee (SSC). This report includes the identification and economic analysis of renewable energy zones, resource areas and discrete renewable projects that may assist California in achieving its renewable energy goals. Additionally, this report identifies and characterizes the individual renewable resources evaluated in the RETI project.

This report is the final Black & Veatch deliverable for the Phase 1 portion of the RETI. In May 2008 the SSC accepted the RETI Phase 1A Report on study methodology, resources and economic assumptions, as well as the methodology to identify and value resources to be included in RETI analyses. In August, 2008 Black & Veatch provided the Draft Resource Report as in interim deliverable for the Phase 1B portion of RETI. That report identified potential resources to be used in the RETI analysis. This report, which replaces the Draft Resource Report, details the resources that were used in the RETI analysis and provides the economic valuation and ranking of Competitive Renewable Energy Zone (CREZ) areas in California and out-of-state resource areas with the potential to deliver renewable energy to meet California Renewable Portfolio Standard requirements.

This report is released in conjunction with an environmental ranking of the CREZs prepared by the RETI Environmental Working Group (EWG). The two reports are designed to provide the SSC the technical information necessary for the SSC to recommend transmission requirements to be considered in Phase 2 of RETI.

1.1 Identification and Ranking of Competitive Renewable Energy Zones and Resource Areas

RETI identified over 80,000 MW of potential renewable resources within 29 CREZs in California, and 40,000 MW located outside of California with the potential to deliver energy to California. Additionally, RETI identified over 25,000 MW of non-CREZ resources in California. The overwhelming majority of this non-CREZ capacity comes from distributed photovoltaic (PV) systems, as well as smaller stand-alone projects (such as biomass) that do not need large-scale transmission upgrades. For discussion purposes, CREZs, stand-alone projects and out-of-state resources have been aggregated into seven Resource Areas. Figure 1-1~~Figure 1-1~~ depicts the resources and CREZs that are included within each resource area.

Figure 1-1. RETI Resource Area.

1.2 California CREZ Economic Rank Cost and Supply Curve

Using the criteria developed and approved by the SSC, Black & Veatch has developed an economic ranking of the 29 identified CREZs. Within seven of these CREZs, Black & Veatch identified and characterized "sub-CREZs," or sets of projects that share common transmission, development timeframe and similar economics. Defining sub-CREZs allows for the development of a supply curve of resources within a CREZ, providing the SSC with finer granularity of the potential cost and development of resources within a CREZ. Table 1-1~~Table 1-1~~ provides the weighted average ranking cost of each CREZ and sub-CREZ in California. The rank cost for a resource includes the cost of generation and transmission, less the capacity and energy value.[1] At the request of the SSC, an alternative rank cost was also developed and is shown in the far right-hand side of the table. This rank cost excludes the capital cost of new transmission lines needed to access the CREZs. If this alternate rank cost were used to rank CREZs, the order of the CREZs in Table 1-1~~Table 1-1~~ would be slightly different.[2]

CREZ rankings as presented in Table 1-1~~Table 1-1~~ and the figures in this Summary do not include the uncertainty bands discussed later in this report.

The RETI analysis shows the need ("net short") for approximately 68,000 GWh/yr of renewable generation in 2020. To meet this need with only CREZ resources in California, the first ten CREZs in Table 1-1~~Table 1-1~~ would be required (using the base case transmission cost assumption). These CREZs are:

- Solano
- Palm Springs
- Victorville-A
- Imperial North-A
- Round Mountain-A
- Fairmont
- Tehachapi
- Riverside East-A
- Victorville-B
- Kramer

[1] All dollar amounts in this report are in 2009 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 5.

[2] The alternate rank cost formulation was developed to demonstrate the effect that the capital cost of transmission has on CREZ rank costs. Transmission cost estimates at this early stage of analysis are known to have a large amount of uncertainty. The alternative rank cost shows that even if transmission capital costs were not considered in the assessment, there would be minimal impact on the CREZ rank order.

Table 1-1. Weighted Average CREZ Rank Costs.

CREZ Name	Net Capacity (MW)	Annual Energy (GWh/yr)	Cumulative Energy (GWh/yr)	Weighted Average Rank Cost ($/MWh) *	
				Base Trans. Cost	No Trans. Cap. Cost
Solano	894	2,721	2,721	-29	-29
Palm Springs	770	2,465	5,186	-20	-26
Victorville-A	800	2,112	7,298	-17	-21
Imperial North-A	1,370	10,095	17,393	-13	-13
Round Mountain-A	240	1,598	18,990	-11	-22
Fairmont	6,918	18,318	37,308	-9	-11
Tehachapi	9,642	25,091	62,400	-3	-9
Riverside East-A	1,000	2,339	64,739	3	3
Victorville-B	895	2,267	67,006	4	-2
Kramer	6,627	16,251	83,257	5	-3
Inyokern	2,887	7,136	90,393	8	-3
Owens Valley	1,400	3,433	93,826	10	-7
Lassen South-A	1,000	3,010	96,836	14	3
Twentynine Palms	800	1,944	98,779	15	9
San Bernardino - Lucerne	4,290	10,722	109,501	16	7
Pisgah-A	1,800	4,283	113,785	16	-1
San Diego South	678	1,829	115,614	16	12
San Diego North Central	281	702	116,316	19	15
Carrizo North	1,600	3,225	119,541	19	11
Barstow	2,136	5,106	124,647	21	8
Lassen North-A	333	982	125,629	22	12
Riverside East-B	6,800	15,552	141,181	22	16
Cuyama	400	847	142,028	24	8
Pisgah-B	3,790	8,844	150,872	27	11
Mountain Pass	2,878	6,942	157,814	27	14
Iron Mountain	5,662	12,713	170,527	27	13
San Bernardino - Baker	1,200	2,705	173,232	28	23
Imperial North-B	1,830	4,282	177,514	29	14
Victorville-C	340	860	178,373	29	12
Imperial South	3,745	8,776	187,149	31	16
Imperial East	1,723	3,991	191,140	34	28
Round Mountain-B	187	705	191,845	38	14
Needles	1,061	2,517	194,361	39	17
Carrizo South	3,000	6,118	200,480	41	18
Santa Barbara	433	1,121	201,601	43	13
Lassen South-B	1,200	2,379	203,980	48	14
Lassen North-B	2,001	4,140	208,119	49	25

* The base transmission cost case (first column) includes all elements of the rank cost formulation as described in this report. The second column excludes the capital cost component of the transmission cost from the rank cost formula.

These CREZs represent the most cost-effective large scale resources in the state. The resources include geothermal, wind, and solar resources throughout the state, though the overwhelming majority of these resources are located in southern California, specifically in the Tehachapi Mountains, Salton Sea area of Imperial County, and the Mohave Desert. Southern California resources rank highly due to the quality of solar resource and the assumed transmission availability in these areas.[3]

There are relatively few cost-competitive resources located in northern California, as the solar and wind resource in northern California is poor relative to southern California. Additionally, northern California resources tend to be located in isolated areas way from the bulk transmission system, and the cost to interconnect these resources to the grid contributes to the poor economics.

Figure 1-2~~Figure 1-2~~ depicts the California CREZs that are available to meet the net short requirement by cost and resource quantity. This figure depicts the rank cost with the base case transmission cost assumption. 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, as discussed further in the next section.

Figure 1-3~~Figure 1-3~~ depicts the same information as Figure 1-2~~Figure 1-2~~ except the transmission capital cost component has been removed from the rank cost formulation. While the apparent rank costs of nearly all CREZs/resource areas would fall if no transmission costs were assumed, the only resource area that would shift into the top ten CREZs/resource areas would be the British Columbia-B resource. British Columbia resources areas are the furthest away of all resources studied in this project. This scenario is discussed further in Section B of this report.

Rank costs presented in the remainder of this report include the transmission capital cost component unless otherwise indicated.

[3] Discussed in Section 3, RETI assumed CAISO-approved and publicly-owned utility (POU) approved transmission would be constructed, including Southern California Edison's Tehachapi and Devers-Palo Verde 2 lines, San Diego Gas & Electric's Sunrise Project, and Imperial Irrigation District's / Los Angeles Department of Water and Power's Green Path line. The capital costs for this transmission were assumed to be included in utility transmission rates, and were not considered as an incremental cost to the resources interconnecting to this transmission.

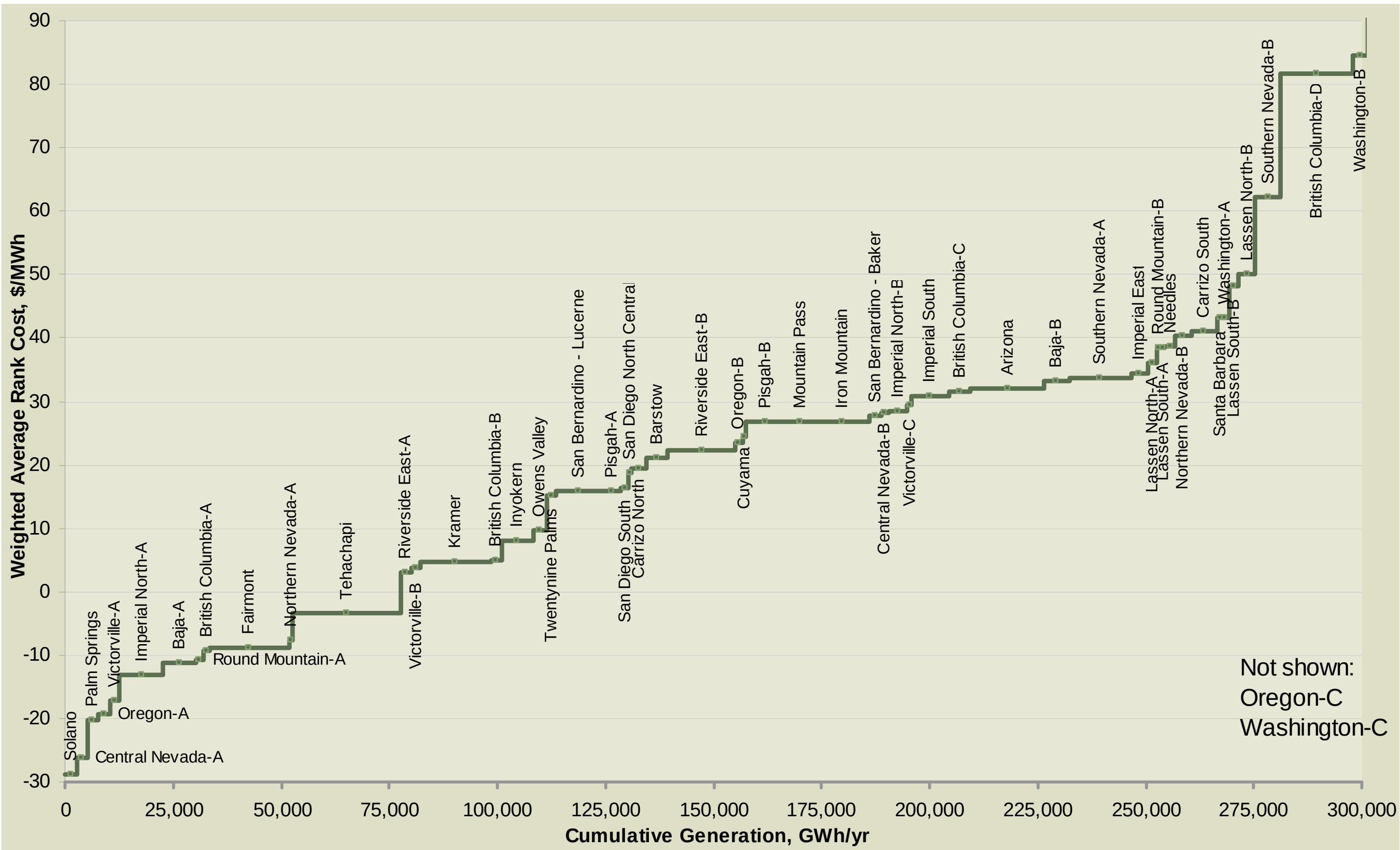


Figure 1-2. Weighted Average Rank Cost ($/MWh) for CREZ and Resource Areas.

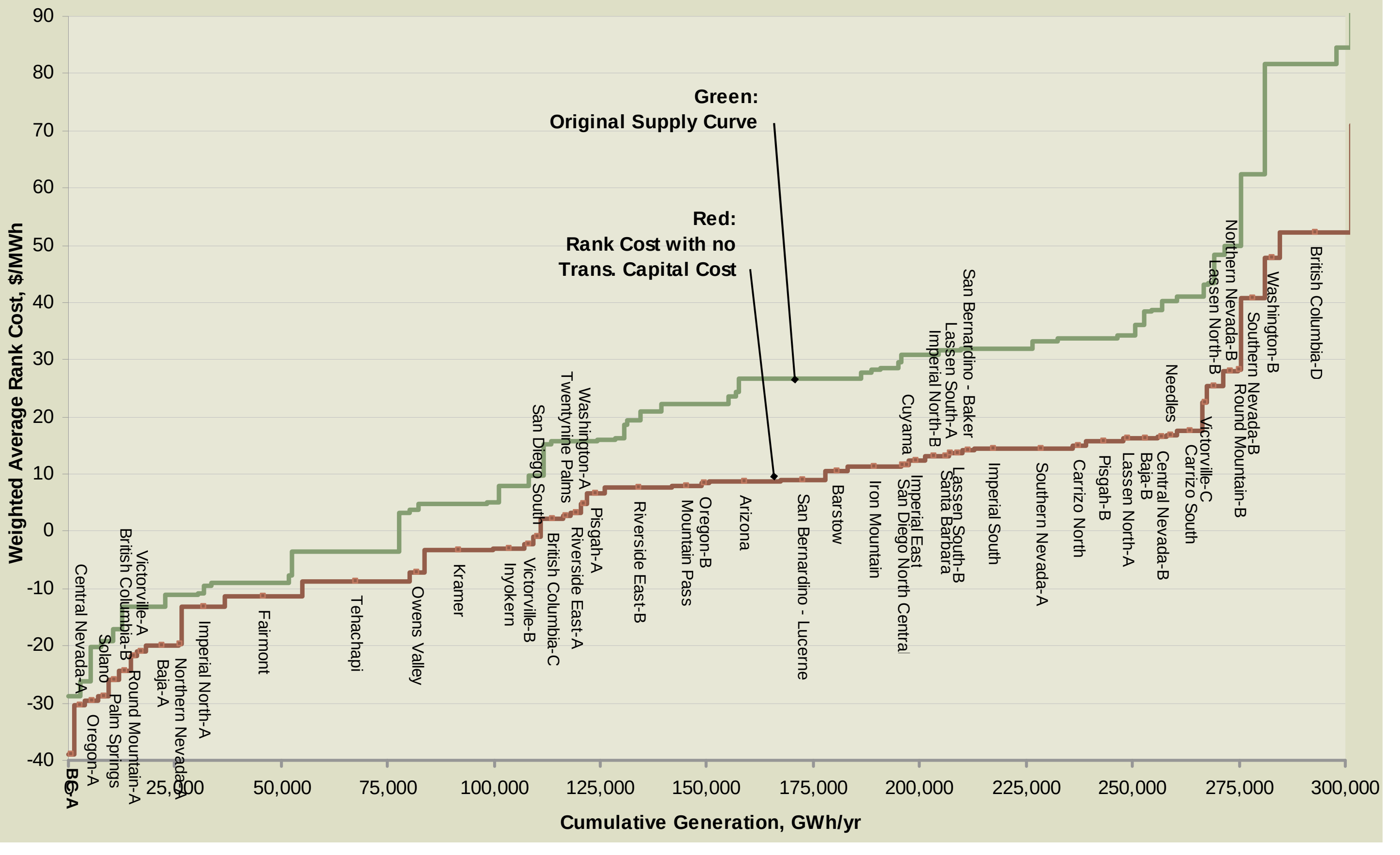


Figure 1-3. Impact of Removing Transmission Capital Cost from all Resources (in Ascending Order).

1.3 Economics of Out-of-State Resources

In addition to the California CREZs, there appear to be out-of-state resources that could justify the cost of new transmission construction and still be competitive with in-state California resources. RETI identified over 40,000 MW of potential resources out-of-state, with generation potential of approximately 110,000 GWh/yr. Resources were identified in Arizona, Nevada, Oregon, Washington, British Columbia, Canada (B.C.) and Baja California Norte, Mexico ("Baja"). Of these, about 15,000 GW/yr were modeled to be competitive with California CREZs, as summarized on Table 1-2~~Table 1-2~~. These resources include wind and geothermal in B.C, geothermal in Oregon and Nevada, and wind resources in Baja. Wind resources in Mexico look particularly promising, and more study is recommended to refine the economic estimates and the environmental factors.

In addition to the base case economic assessment, several sensitivity investigations were performed that included out-of-state resources. The result of these studies was that there could be scenarios where almost double the capacity shown in Table 1-2~~Table 1-2~~ could be cost competitive.

Table 1-2. Base Case Cost-Competitive Out-of-State Resources.

Region	Capacity (MW)	Annual Energy (GWh/yr)	Weighted Average Rank Cost ($/MWh)
Nevada	427	2,976	-21
Oregon	392	2,848	-19
Baja California Norte*	2,368	7,633	-11
British Columbia**	340	1,553	-9

Notes:

* Assessment of Baja wind resources in this project was preliminary. Evidence exists that additional resources may be cost effective, and this should be further explored in Phase 2.

** An additional 700 MW of resource (1040 MW total) is available at a relatively competitive cost of $5/MWh.

1.4 Economics of Non-CREZ Resources

As with out-of-state resources, there are several non-CREZ resources (areas less than 250 MW) that are cost competitive and may be used to serve California's energy requirements and satisfy the RPS goals. About 70,000 GWh/yr of smaller-scale non-

CREZ resources were modeled in California, the majority of which were 20 MW solar PV projects. Most biomass projects are also not within CREZs, as they are generally smaller and can be sited to take advantage of existing transmission infrastructure. Many of the non-CREZ resources are located in northern California.

Resources that are not reliant on large-scale transmission planning to be integrated into the system may be able to be brought on-line faster and at lower cost than CREZ resources that are reliant on such transmission.

Of the non-CREZ resources, a total of seven wind and geothermal projects were considered competitive with California CREZs in the base case. These projects total about 430 MW and 2,200 GWh/yr of annual generation. This is a relatively small fraction of the total supply needed to meet California's RPS. Because of the uncertainty of the costs and timing for the large scale transmission needed to reach CREZs, it is very likely that significantly more than 430 MW of non-CREZ resources will be developed in California.

1.5 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. As a result of this assessment it was found that the following CREZs and resource areas could be cost-competitive under certain scenarios[4]:

- Twentynine Palms
- San Bernardino - Lucerne
- Pisgah-A
- San Diego South
- San Diego North Central
- Carrizo North
- Lassen North-A
- Lassen South-A
- Santa Barbara

[4] This list includes CREZs identified by the sensitivity analysis to be potentially cost competitive. If the full range of the uncertainty bands is considered, nearly every CREZ and resource area is potentially cost competitive under certain scenarios. For example, if costs have been significantly overestimated only for high cost resources, they may be cost competitive with lower cost resources.

- Victorville-C
- Round Mountain-B

In addition, a sensitivity assessment of reduced solar costs was performed with significant implications. The sensitivity study used thin-film manufacturer cost targets as the basis for the solar capital cost. This assessment indicated that the costs for the large-scale solar CREZs would drop significantly. Figure 1-4~~Figure 1-4~~ shows how the resource supply curve would be impacted by assuming lower costs for solar deployment. Another significant conclusion from the sensitivity study is that large amounts of distributed non-CREZ solar PV resources could be economic. The cost-competitive non-CREZ resources increase to about 45,000 GWh/yr, over two-thirds of the net short requirement. It is important to note that the non-CREZ resources were assumed to be connected to smaller substations on the 50-200 kV transmission system. Large scale deployment of hundreds of such systems would likely require system upgrades and reinforcements; however, this was beyond the scope of this study.

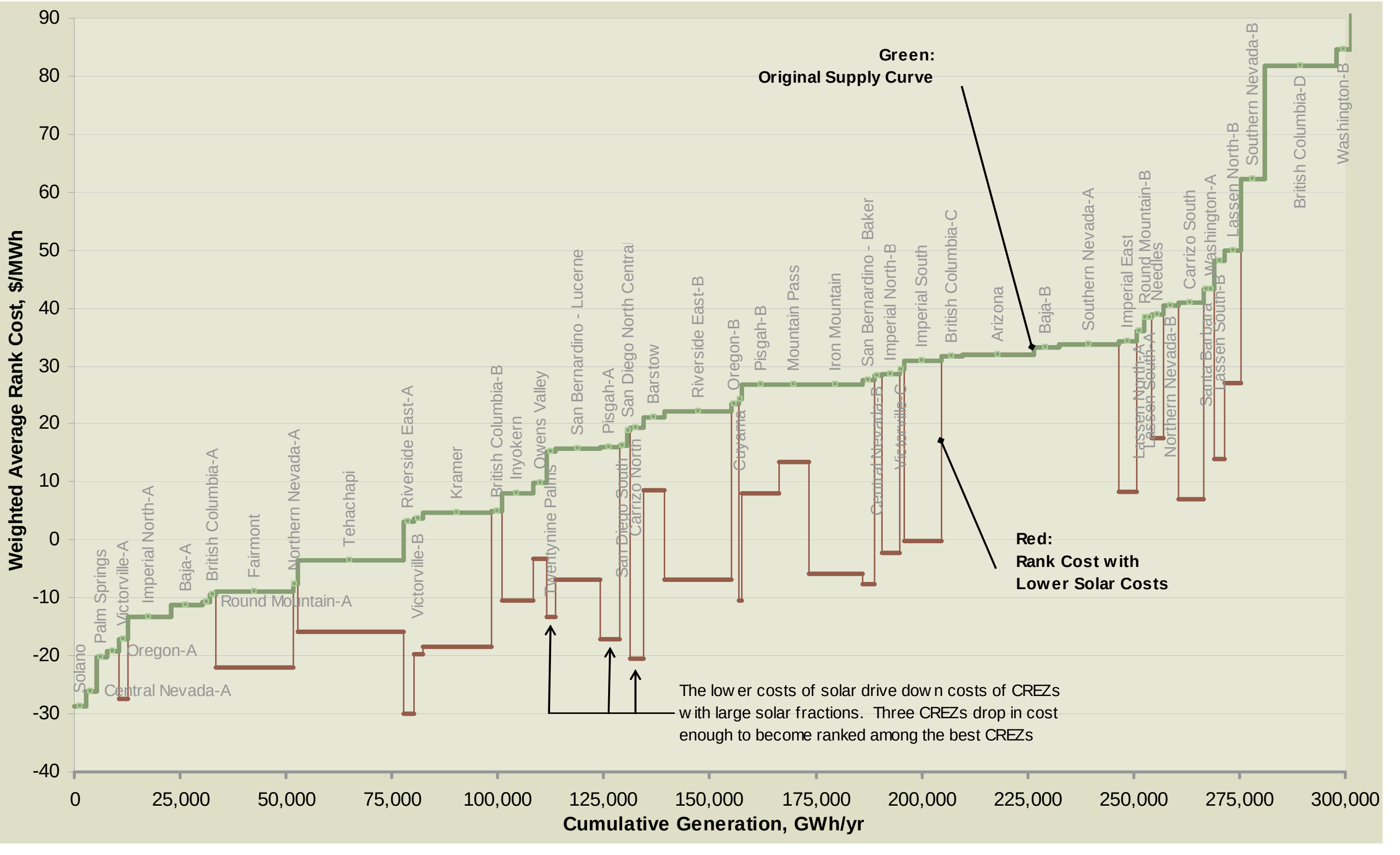


Figure 1-4. Effect of Reduced Solar Costs on CREZ Supply Curve.

Note that this figure does not show the reduced output (generation, GWh) of thin film solar PV. It is intended to just highlight the potential cost savings.

1.6 Summary of Renewable Energy Resources

This report identifies and characterizes over 2,100 individual projects. Black & Veatch initially identified over 3,600 projects, with a total capacity of over 500 GW, which were detailed in August 2008 Phase 1B Draft Resource Report. Based on recommendations by the SSC, Black & Veatch culled this list using economic screens to focus the analysis to the most economically developable resources. Table 1-3~~Table 1-3~~ presents a summary of resources by type and resource area. Individual resource identification and characteristics are included in Appendix D.

Table 1-3. RETI Resource Summary by Resource Area

	Biomass	Geo-thermal	Dist. Solar PV[a]	Large Solar[b]	Wind	Total
Capacity (MW)						
Central Coast	23		920	5,000	509	6,452
Northern CA	1,150	460	16,480	2,400	3,518	24,008
Salton Sea/SD	159	1,434	1,640	7,000	1,128	11,361
Southeast CA	91		4,020	29,000	5,579	38,690
Tehachapi/Owens	302	24	4,400	21,800	5,474	32,000
N. OOS[c]	2,423	764			15,080	18,267
Nevada		1,283		7,429	1,475	10,186
OOS – SW[d]			40	7,129	5,000	12,169
Total	**4,148**	**3,965**	**27,500**	**79,758**	**38,020**	**153,390**
Generation (GWh/yr)						
Central Coast	159		2,046	10,727	1,410	14,342
Northern CA	8,060	3,381	33,951	4,858	9,889	60
Salton Sea/SD	1,112	11,074	3,785	16,580	3,121	35,673
Southeast CA	638		9,215	70,621	15,571	96,046
Tehachapi/Owens	2,118	168	9,683	56,428	16,102	84,500
N. OOS	16,980	5,827			37,427	60,234
Nevada		9,165		17,761	3,203	30,130
OOS – SW			95	17,722	14,449	32,266
Total	**29,068**	**29,616**	**58,775**	**194,698**	**102,497**	**414,653**

Notes:

[a] This column quantifies the potential of small-scale, distributed solar PV projects 20 MW in size. Potential solar PV resources are much larger than shown in this table.

[b] This column quantifies the potential of large-scale solar plants. These project sites can utilize either solar thermal (200 MW per project) or solar PV (150 MW per project) technology. Solar thermal resource potential is quantified in this table. Solar PV technology is evaluated elsewhere in this report.

[c] North out-of-state = Oregon, Washington, British Columbia.

[d] Southwest out-of-state = Arizona and Baja.

1.7 Use and Purpose of this Report

This report is intended to provide the SSC the economic ranking and valuation of California CREZs and the economic valuation for non-CREZ resources located within and outside of California. This information, coupled with the EWG analysis of the California CREZs, will assist the SSC in developing recommendations for transmission projects to access renewable resources in Phase 2 of RETI.

1.8 Recommended Phase 2 Issues

During the Phase 1 analysis Black & Veatch encountered numerous issues that it recommends be further explored in Phase 2. These are discussed further in this section.

RETI is intended to be a long-term and dynamic process designed to identify promising renewable resources for California and the transmission to access these resources. The information included in this Phase1B report is designed to provide RETI participants and stakeholders with the best available economic analysis of currently-known resources. The Phase 1B report includes a base case and several scenario analyses designed to reflect a plausible range of potential future scenarios. In subsequent phases, RETI is anticipated to be adapted to eliminate resources and areas with limited potential and to incorporate new information on resources, requirements, economics and other significant factors as it becomes available. The RETI analysis will be tailored in the future to meet the needs of the time.

There is a plethora of potential alternative assumptions, sensitivities, and analytical approaches that could be used in the RETI process, both in this phase and future phases. There is no single “correct” approach to conducting such a broad economic assessment. Comments on the report identified several areas where alternative methodologies may be considered in the future, and others identified critical assumptions that may need to be reviewed as they have substantial impact on the analysis results. Highlight below are several of the areas where alternative assumptions and approaches may ultimately result in different resource rankings.

1.8.1 Transmission Methodology

RETI employed an incremental transmission cost approach, adding transmission capacity to deliver all energy identified within in a CREZ to a designated major load area. This incremental cost approach includes the aggregate cost of transmission lines, substations and ancillary facilities, taking into account line losses and variable costs. RETI Phase 1 added transmission capacity to transmit renewable energy based on potential generator production. No load-flow analyses were conducted, nor were potential reliability benefits of new transmission considered in the transmission costs. In addition, regional transmission benefits and potential cost sharing (such as with out-of-state utilities) were not captured in the analysis.

The advantage to using the incremental facility approach in RETI is that it identifies, quantifies and costs specific transmission facilities required to deliver a quantity of energy to the grid and to load areas. Alternative approaches, such as a simple percentage of resource cost or estimating a flat dollar-per-MW-mile, will provide for a transmission cost but do not adequately account for the cost of transmission based on distance from generation site to delivery point. A limitation to this approach is that it may not mirror the development of transmission, even among the same resources identified in RETI. Transmission lines will likely be added to the California grid to not only interconnect specific renewable resources to a specific load area, but to enhance reliability and reinforce the transmission system in total. This level of analysis can only be completed by conducting comprehensive load-flow modeling, which is the focus of the RETI Phase 2 effort.

The relative costs of CREZs may change when a more accurate transmission system cost assessment is complete. This assessment would include the potential to serve multiple zones and balancing areas as opposed to the incremental approach taken in Phase 1B.

1.8.2 Capacity Costs and Integration Costs

To value the capacity of renewable resources RETI used an assumption developed by the California Energy Commission in their cost of generation analysis that the installed cost of a fully dispatchable combustion turbine is $204/kW-year. This assumption was agreed to among the Phase 1A working group in Spring 2008 and used in the resource valuation and rank cost calculation used in RETI. To understand the sensitivity of the resources and CREZs to changes in the capacity value, Black & Veatch conducted a sensitivity analysis assuming the capital cost of a CT was half of the cost identified by the CEC.

The appropriate method to value capacity from resources is hotly debated. One could argue that to the extent that a renewable resource results in avoiding the development of conventional resources, the total cost of developing that generation is part of the capacity value. This “raw” capacity value is equal to the capital cost of the avoided resource. This value does not however, consider the market revenues of energy generation when dispatching that resource. Arguably, one would only build generation with the intention of using it at least partly to serve demand, and the revenues earned from selling energy from the facility when it is infra-marginal should be considered when valuing the capacity benefit of the resource. In this case the value of capacity is the inferred value between the total cost of the resource less the market revenues earned by the resource. Appropriate capacity valuation methods should be explored further in the next phase of RETI.

In addition to capacity value, integration costs have not yet been included in the RETI analysis. As information is developed on appropriate assumptions to use for the cost to integrate intermittent wind and solar resources, these should be included in the RETI analysis.

1.8.3 Baja California Norte Wind Resources

Black & Veatch conducted resource assessments for all resources areas located in the United States. Due to limited available public information, Black & Veatch relied on a variety of primary and secondary sources of information to assess the developable potential of renewable resources in these regions. Based on CAISO queue applications, Black & Veatch identified approximately 5,000 MW of developable wind potential in Baja. Comments were received that this substantially understates the resource potential of the region.

Upon further review Black & Veatch identified a technical potential of approximately 25,000 MW of wind resources, though this estimate has no consideration for development constraints. Further analysis is required to determine the developable potential to result in an estimate consistent with those developed for American locations, factoring in environmental constraints, infrastructure requirements (for example, roads and transmission ROW) and development costs.

1.8.4 Project Identification Limitations

Black & Veatch conducted resource assessments and project identification for all resource areas to assess the developable potential of renewable resources in these regions. The assessment is based on the best available public information on resource potential; however, Phase 1 was not a detailed siting investigation. There are known issues with certain CREZs such as land ownership fragmentation that should be further investigated in Phase 2.

To insure that RETI includes the best available data in future phases, Black & Veatch recommends that project development and resource assessments be continuously monitored and the RETI dataset be refreshed to insure that it includes the broadest set of viable and developable projects.

2.0 Introduction

The objective of this report is to economically rank California CREZs and non-CREZ resources in and outside of California for the California Renewable Energy Transmission Initiative project. Additionally, this report identifies and details the individual renewable resources that were used in the RETI analysis. This section provides a brief background and overview of this report.

2.1 Background

This report is the final Black & Veatch deliverable for the Phase 1 portion of the RETI initiative. In May 2008, the SSC accepted the RETI Phase 1A Report on study methodology, resources and economic assumptions, as well as the methodology to identify and value resources to be included in RETI analyses. In August, 2008 Black & Veatch prepared a Draft Resource Report as an interim deliverable for the Phase 1B portion of RETI. This report details the economic valuation of Competitive Renewable Energy Zones (CREZ), resource areas and individual non-CREZ resources. This report also includes identification and characterization of all of the resources used in the final RETI analysis.

This report is released in conjunction with an environmental ranking of the CREZs prepared by the Environmental Working Group. Figure 2-1~~Figure 2-1~~ shows the relationship of the material in this report to the overall RETI Phase 1 process.

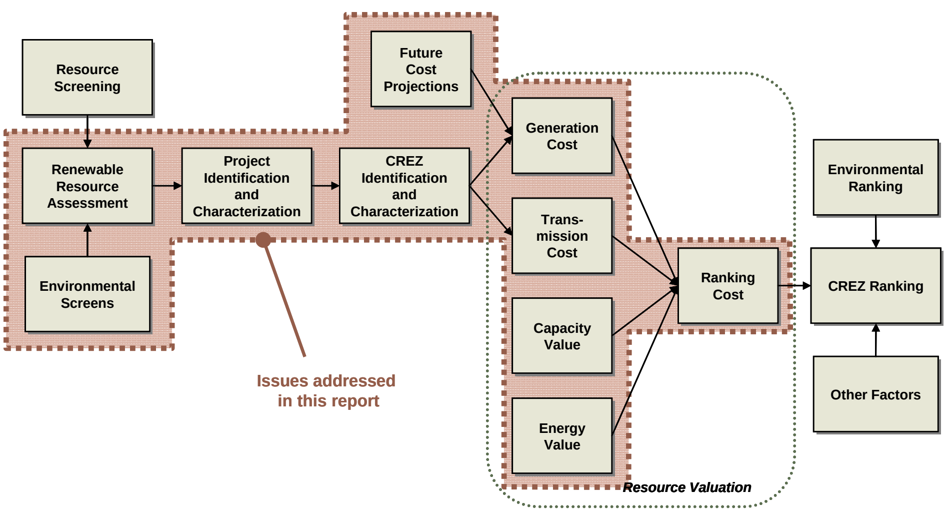


Figure 2-1. Overview of RETI Phase 1 Methodology.

2.2 Approach

The identification and characterization of CREZs requires consideration of a variety of factors affecting development, including the physical proximity of resources, the location of these resources relative to the transmission system, and the availability, or potential availability, of transmission to serve these projects. In developing this ranking of CREZs and sub-CREZs, resource areas and individual resources, Black & Veatch used the methodology proposed in Phase 1A and approved by the SSC. This is discussed in detail in Section 3.

2.3 Report Organization

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

- **Section 3 – Methodology and Assumptions**: This section describes the process, methodology and assumptions used to develop the CREZ, resource area and individual project economic rankings.
- **Section 4 – Competitive Renewable Energy Zones and Resource Areas:** Eight Resource Areas were defined in the RTEI analysis, including five located in California and three for out-of-state resources. This section provides a discussion of the resource area characteristics and presents summarized resource and ranking information.
- **Section 5 – Rank Costs and Supply Curves:** Supply curves were developed to rank resources by region. This section details the resource rank costs and presents the supply curves for the resources.
- **Section 6 – Generation Resources:** RETI identified and included over 2,100 discrete resources in this analysis, including biomass, geothermal, large-scale solar, disturbed solar photovoltaic, and wind resources. This section discusses the methodology used to characterize these resources.

2.4 Accompanying Maps

In conjunction with this report, Black & Veatch has developed a series of high-resolution maps showing the location of CREZs and projects. Additional maps identify and depict resource exclusion areas. The following maps are available for download at project website, www.energy.ca.gov/reti:

Resource Exclusion Maps

- General resource exclusions
- Solar PV resource exclusions

- Solar thermal resource exclusions
- Wind resource exclusions

Project Identification Maps

- Biomass
- Geothermal
- Solar PV
- Solar thermal
- Wind

CREZ/Resource Region Maps

- Competitive Renewable Energy Zones
- Resource Areas

3.0 Methodology and Assumptions

The foundation for the methodology and assumptions for RETI Phase 1 were established in the Phase 1A report. This section describes how some key components of the methodology were ultimately implemented to arrive at the results presented in this report.

3.1 Project Identification & CREZ Development Process

To identify individual projects for RETI, Black & Veatch implemented the methodology detailed in the Phase 1A report. The main steps of the process are shown in Figure 3-1~~Figure 3-1~~. The specifics of the project identification and characterization process for each technology is outlined in Section 6 of this report.

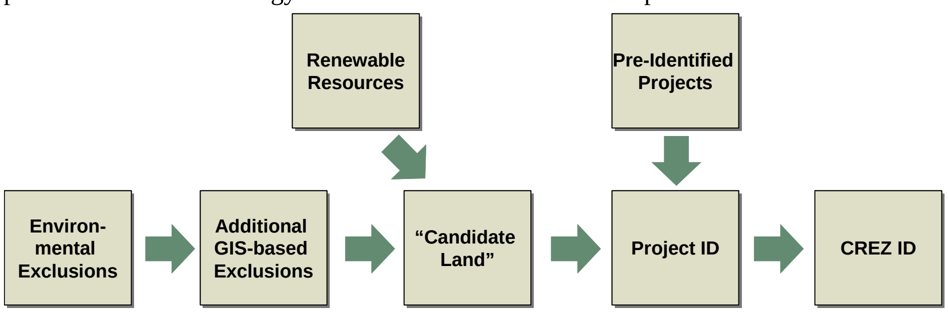


Figure 3-1. Project Identification & CREZ Development Process.

3.1.1 Project Identification and Characterization

The first step in this process was to develop a detailed set of environmental exclusion areas which indicated (1) areas completely off-limits for development and (2) areas where development is not preferred. These environmental exclusions where then combined with additional land use exclusions (such as airports, military bases, and urban areas) using geographic information systems (GIS) software. The GIS-based exclusions were removed from the parent renewable resource data set in order to identify “candidate land” for development.

A parallel process was undertaken to identify all proposed projects and potential projects where commercial interest has been expressed. These projects were assembled from a variety of public data sources including generator and market participant information submittals, BLM applications, commercial databases and power purchase agreements (PPAs) with utilities. These projects are known as “**pre-identified projects**”.

It is important to note that the pre-identified projects have not been directly modeled in this report. Rather, Black & Veatch has identified resources in the same vicinity of the project. Sometimes the boundaries of Black & Veatch's projects match the pre-identified project boundaries, in other cases a portion of the boundaries overlap or the projects are nearby. In all cases, Black & Veatch made independent estimates of project capacity. The next step was to supplement the set of resources with **"proxy projects"** using the project identification criteria detailed in the resource chapters of this report and applying the exclusion criteria discussed above. This data was then validated with interconnection queue data to insure that sufficient projects had been identified in a given area.

Performance and cost estimates were created for each project. This process was necessarily different for each technology. The methodology for creating performance and cost estimates for each technology is outlined in Section 6.

3.1.2 CREZ Development

Once the projects were identified they were grouped into CREZs that shared common geography and transmission requirements. An effort was made to keep the CREZs to a manageable size, which practically worked out to be less than 10,000 MW and more than 250 MW. A conceptual transmission gathering system was designed within each CREZ including gen-ties and trunklines. The results of this effort are presented in Section 4.

When necessary, CREZs were split into "sub-CREZs" based on economics. This process is described in Section 5 of the report.

3.2 Exclusion Areas

In the identification of renewable resources and CREZs, Black & Veatch used a series of exclusion screens to filter out land and resources that would not be appropriate for development and should not be part of the RETI analysis. This includes land that is environmentally or culturally sensitive, restricted for military purposes, or inappropriate for certain types of development (such as wind development near airport runways). Most of the screens were applicable to all resources, though some screens were applicable only to certain technologies.

To develop the exclusion screens, Black & Veatch solicited and received input from a variety of sources. Environmental, cultural and land use screens were vetted by the Environmental Working Group and provided to Black & Veatch, while military restrictions on development were provided by the military. In developing screens that impacted specific types of resources, Black & Veatch consulted with developers and stakeholders in those represented industries. Table 3-1~~Table 3-1~~ is a discussion of the screens that were applied in the resources identification process.

Table 3-1. Excluded Lands for RETI.

	Geo-thermal	Solar PV	Solar Thermal	Wind	Notes
Environmental black areas	Yes	Yes	Yes	Yes	
Environmental yellow areas	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Wetlands and water bodies	Yes	Yes	Yes	Yes	Dry lakes not excluded
Native American reservations	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Military lands	Yes*	Yes*	Yes*	Yes*	*Pre-identified projects OK
Mines (surface)	Yes	Yes	Yes	Yes	
Urban areas	Yes	Yes, +buffer	Yes, +buffer	Yes, +buffer	buffer up to 3 miles depending on population
Airports	Yes	Yes	Yes	Yes, +buffer	Major airports only. Wind buffer is up to 5 miles.
Military flyways	No	No	No	Yes* (Red)	*Pre-identified projects OK in red zones. All other open.
Williamson Act Prime Agricultural Land	No	Yes*	Yes*	No	*Pre-identified projects OK
Williamson Act Non-Prime Agricultural Land	No	Yes**	Yes**	No	**Excluded until 2018, pre-identified projects OK
Renewable resource quality	No	No	< 6 kWh/ m^2/day	< 6.3 m/sec	
Min. contiguous square acreage	No	160	1280	none	640 acres = 1 section = 1 square mile
Land slope	No	> 5%	> 2%	> 20%	Geothermal evaluated on case by case basis
Note: Because biomass plants have very high siting flexibility, explicit land exclusions were not applied. Biomass plants can be easily moved to avoid sensitive areas.					

Figure 3-2~~Figure 3-2~~ shows a comparative example of the exclusions applied near the Tehachapi area for wind and solar thermal resources. The land on these maps that is shown in white is known as “candidate land”. This is land that has passed all environmental, land use, resource, and other restrictions. Full scale maps are available for download at the project website (www.energy.ca.gov/reti) for the following resources:

- General resource exclusions
- Solar PV resource exclusions
- Solar thermal resource exclusions
- Wind resource exclusions

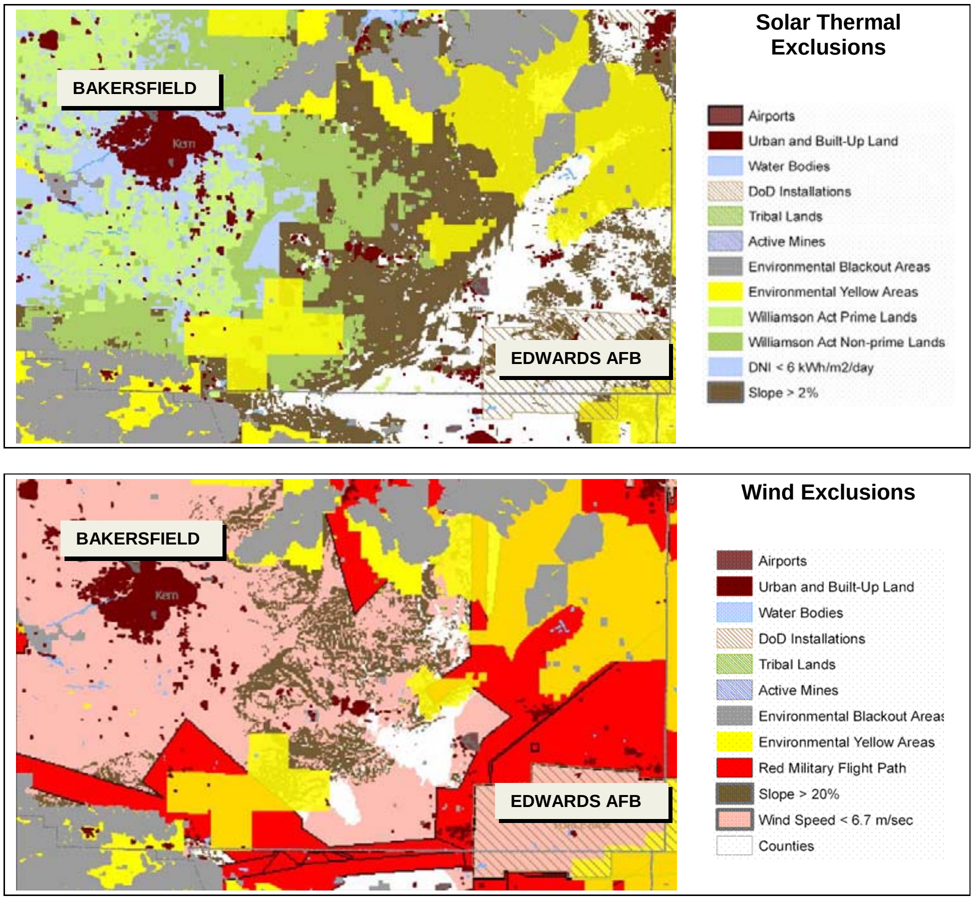


Figure 3-2. Example of Wind and Solar Thermal Exclusions Near Tehachapi.

The exclusions have simply been applied for the purposes of determining potential developable resources and performing high-level transmission planning. It is very important to emphasize that the purpose of these exclusions is for conceptual transmission planning and not to recommend specific project siting and land use decisions. Conversely, candidate lands shown as "open" for development should not necessarily be assumed to be appropriate for siting plants either. All projects will still need to proceed through all local, state, and federal permitting processes; RETI does not supercede these authorities. Finally, much of the land identified as part of this assessment is privately owned. RETI does not intend to interfere with the decisions of private land owners in any manner.

3.2.1 Environmental, Cultural and Land Use Exclusions

Black & Veatch conformed to the recommendations of the Environmental Working Group on the impact of environmental, cultural and land use concerns on project identification. The Environmental Working Group's report discusses these considerations in depth. It defines Category 1 areas (cited in this report as "blackout areas"), Category 2 areas (cited in this report as "yellow areas"), and the proper treatment of Forest Service land, Native American lands, agricultural lands, and other considerations.

3.2.2 Military Exclusions

The western U.S. and California host extensive military facilities. Two types of exclusions were applied to the project identification process: (1) active military bases and (2) flight zones.

- **Military Bases** – Only pre-identified projects are allowed on base properties. The Department of Defense provided a list of potential projects for consideration (see the next section). This restriction applies to all resources.
- **Flight Zones** – Tall structures can potentially impede military flight operational activities. The Department of Defense has developed a color coding system (Red-Yellow-Green) for air space to identify the review requirements for tall structures. For RETI, this only impacts identification of wind projects. Red land designations are the most restrictive, and projects may not be allowed in red areas. However, the exclusion is not categorical, and for this reason red lands are treated as Category 2 lands. The military's other designations (yellow and green air space) were not included as exclusions.

The proposed expansion of the military facility near Twentynine Palms may have an impact on the RETI analysis, but it has not yet been considered at the time of this report. Black & Veatch intends to consider the expansion before the final version of this report.

3.2.3 Other Exclusions

Other development restrictions were generally applied to all resources including wetlands and water bodies, urban areas, and active mines. Development of larger renewable energy projects in these areas is generally very difficult or impossible.

3.2.4 Resource Specific Exclusion Zones

In addition to these general exclusions impacting all development projects, RETI has developed exclusion areas that impact certain types of resources. For example, land with slope greater than 2 percent was not considered for proxy solar thermal projects. These exclusions are discussed in Section 6.

3.2.5 Limitations of the Project Identification Process

Black & Veatch conducted resource assessments and project identification for all resources areas to assess the developable potential of renewable resources in these regions. This methodology is discussed at length in this report. Given the vast amount of land and the discrete location of most renewables, the Black & Veatch project survey had several limitations, which could potentially result in significant variations in the estimates of generation potential and actual development in certain areas. These include the following.

- The assessment is based on the best available high-level resource data. However, these high-level assessments are known to be uncertain. Site-level resource data would improve the assessment, but there was no practical way to include these in this stage of analysis.
- Detailed siting reviews for each project were not conducted. There may be constraints that would preclude development of a site including high fragmentation of land ownership, constructability concerns, flood plains, presence of cultural resources, and other factors.
- It has been assumed that pre-identified projects could be sited in certain sensitive areas (for example, “yellow” areas and military flyways). This may not be possible after further project review.
- Local-zoning regulations and laws were not reviewed or applied to the assessment. Further, known historical opposition to project siting was not considered a fatal flaw in the assessment.
- In certain CREZs, a large fraction of the projects modeled are “proxy” projects. This indicates that there is limited *known* commercial interest in the CREZ, and the viability of development within these areas should be further reviewed. It may be that there is development activity is actually occurring, but the developer has chosen not to make this public as part of the RETI process. In contrast, however, there may not be any developer interest in this area for other unidentified reasons. A summary of the amount of proxy projects in each area is provided in Section 4.

- RETI collected information on projects by surveying public information and requesting project information from developers and project advocates. While known-pre-identified projects were included in RETI, there will inevitably be additional projects that were not included in the RETI analysis. An example of such a project is the Burney wind project, which was only identified in November after the developer had executed a PPA with a utility.

It is recommended that project identification be continuously monitored and the RETI data set be refreshed in subsequent RETI phases to ensure that RETI includes the broadest set of viable and developable projects.

3.3 Pre-Identified Projects

Planned projects and projects under construction were identified using publicly available information. That information came in a variety of forms. Table 3-2 summarizes the information received on pre-identified projects, and the specific data sources are discussed further below.

Table 3-2. Pre-Identified Resources by Source and Resource Type (All locations)

	Biomass		Geothermal		Large Solar[a]		Wind	
	No. Proj.	MW	No. Proj.	MW	No. Proj.	MW	No. Proj.	MW
PPAs	12	125	9	379	15	2,144	28	2,903
BLM Apps.	0	0	0	0	217	87,260	93	671[b]
RFIs	1	11	15	1,972	19	10,392	35	11,421
Military	0	0	1	100	6	586	1	74
TOTAL[c]	**13**	**136**	**25**	**2,451**	**267**	**100,382**	**178**	**14,398**
B. Columbia	43[d]	1,520	7	244	0	0	NA	6,630[e]

Notes:

[a] All pre-id solar projects were combined into a list of “large solar” projects, regardless of whether they employed solar thermal or solar PV technology. All large solar projects were then modeled as either solar thermal or solar PV.

[b] Most BLM wind applications do not report expected MW. Applications that did not report MW were usually applications to install MET towers, rather than to construct plants. These projects were not modeled in the RETI analysis.

[c] Totals do not include British Columbia resources identified by Pacific Gas and Electric in a separate study. Numbers are presented here for comparison.

[d] Only aggregate resource data was available for BC biomass. The capital cost per kW of a biomass project depends on the project’s size. To estimate capital costs for BC biomass projects, an average project size of 35 MW was assumed. The number of biomass projects was determined by dividing the aggregate biomass resource potential in MW by the average project size in MW.

[e] Only aggregate resource data was available for BC wind. The number of individual wind projects was not assessed.

3.3.1 Generator Data Request

To ensure that RETI included commercial projects, CEERT circulated a data request for generators to provide information on existing and planned projects. The data request sought information on project ownership, development stage, location, acreage, site control, project type, technology, generation capacity, capacity factor, and interconnection information in its generator RFIs. Responses were received from 16 participants and provided identification of 70 individual projects.

It is important to note that most of these responses did not include specific geographical boundaries for project sites. For this reason, Black & Veatch has attempted to include projects representative of the generator-supplied information in its process. However, the boundaries of actual generator projects have generally not been identified.

Table 3-3. Pre-Identified Projects from Generator Data Request.

	No. of Projects	**MW**
Biomass	1	11
Geothermal	15	1,973
Large Solar	19	10,392
Wind	35	11,421
TOTAL*	**70**	**23,797**

Notes:
* Total does not include PG&E submitted British Columbia resources

3.3.2 Department of Defense Lands Proposed Development

The U.S. Department of Defense (DoD) has established a goal to have 25 percent of its energy requirements met by renewable energy resources by 2025. To effectuate this, the DoD is beginning to actively lease non-mission critical land on military installations for renewable energy development. The DoD has estimated the development of resources at several military installations, as detailed in Table 3-4.

Table 3-4. Pre-Identified Military Projects.

Installation	State	Technology	MW
El Centro Naval Air Facility	CA	Geothermal	100
Fort Irwin	CA	Solar Thermal	150
China Lake	CA	Solar Thermal	112
MAGTFTC Twentynine Palms	CA	Solar Thermal	100
Yuma Proving Ground	AZ	Solar Thermal	100
Sierra Army Depot	CA	Solar Thermal	50
Edwards Air Force Base	CA	Solar Thermal	200
Vandenberg Air Force Base	CA	Wind	74
Source: Tony Parisi, US Navy; Black & Veatch			

3.3.3 Bureau of Land Management Land Leases

Substantial portions of California, Nevada and Arizona lands are under the control of the U.S. Bureau of Land Management (BLM). BLM leases federal lands to private entities for commercial activities, including energy development. Generators seeking to develop projects on BLM land must apply to lease rights of way (ROW)s to use land through the regional BLM office and provide information regarding the type of project, the specific technology that will be used, the project's capacity, location and the acreage requested.

This information is filed and processed at local BLM offices. To meet demand for information and consistency in application treatment, BLM has developed a central database of renewable energy lease applications. RETI used renewable energy ROW data provided by the California, Nevada and Arizona BLMs. California data were used to determine whether or not modeled projects should be considered pre-identified or proxy. California data are considered up to date as of November 2008. Nevada and Arizona data were used to identify and characterize projects in these states. Data for these states are considered up to date as of July 2008. Appendix A includes the BLM applications considered for the RETI analysis provided by the BLM.

Table 3-5. BLM Application Pre-Identified Projects (all locations).

	No. of Projects	Capacity, MW	Acres
Large Solar	124	87,260	1,219,478
Wind	93	671*	761,694
TOTAL	**217**	**87,931**	**1,981,172**

Sources: California Bureau of Land Management, November, 2008; Arizona Bureau of Land Management, July 2008; Nevada Bureau of Land Management, July 2008.

Notes:

* Wind MW are small because most BLM Wind applications do not include capacity

3.3.4 Utility Power Purchase Agreements

Utilities enter into contracts for the purchase of energy from generators. A small amount of information from these contracts is publicly available and provides project type, technology, capacity, general location and projected on-line date. The information is summarized in Table 3-6 and Appendix B includes contract data as summarized by the California Energy Commission.

Table 3-6. Utility Power Purchase Agreement Pre-Identified Projects.

	No. of Projects	Capacity, MW	Generation, GWh/yr
Biomass	12	125	854
Geothermal	9	379	2,921
Solar PV	4	15	33
Solar Thermal	11	2,129	5,173
Wind	28	2,903	8,068
TOTAL	**64**	**5,552**	**17,051**

Source: California Energy Commission, "Database of Investor-Owned Utilities' Contracts for Renewable Generation, Contracts Signed Towards Meeting the California RPS Targets," available at: http://www.energy.ca.gov/portfolio/contracts_database.html, July 9, 2008

3.3.5 Transmission Operator Interconnection Queues

In order to access to the electric transmission system to deliver energy, generators must submit an interconnection request with the interconnecting transmission owner.

The interconnection requests include project type, technology, capacity, general location and planned substation interconnection information. Pursuant to FERC policy, basic data from the queue applications is publicly available. Pending requests are considered "in queue." Due to the recent surge in interconnection requests, transmission operators have extensive interconnection queues.

Black & Veatch reviewed transmission queue information for all major transmission owners in California, Arizona and Nevada. While indicative of commercial interest, the queue information does not provide sufficient facility information necessary for RETI to define "pre-identified" projects based on this data. However, Black & Veatch used this information to validate other information on project development. This information was specifically used to ensure the number of projects and generation capacity modeled by Black & Veatch in a given area equaled or exceeded the number of projects planned by developers in each county in the study area. Table 3-7~~Table 3-7~~ identifies the transmission queues that were reviewed by Black & Veatch. Appendix C provides all interconnection queue information.

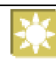
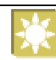
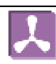
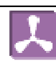
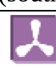
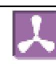
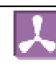
Table 3-7. Generation Interconnection Queue Data Sources.
Arizona Public Service Company
California Independent System Operator
Imperial Irrigation District
Los Angeles Department of Water and Power
Nevada Power Company Generator
Salt River Project
Sierra Pacific Power Company
Tucson Electric Company
Western Area Power Administration

3.4 Out-of-state Resources

Out-of-state resources were handled differently than in-state resources for several reasons. In many cases, Black & Veatch did not have access to the same high-quality data that are available for renewable resource potential or land use for California. In addition, the EWG had not defined land constraints for out-of-state areas. Black & Veatch also had to make assumptions about how much of the out-of-state resources would be available for export to California due to (1) resource competition from regional utilities and (2) transmission limitations on bringing resources to California. These latter two factors greatly limit the amount of out-of-state resources that California can practically rely on.

Black & Veatch had screened out many resources in different regions based on the preliminary resource assessment performed in Phase 1A. For example, Arizona wind resources were determined to be relatively small and high price, making them unlikely to be candidates for development of large transmission lines for export to California. Table 3-8~~Table 3-8~~ shows the out-of-state resource recommendations from the Phase 1A report.

Table 3-8. Resource Areas Studied in Phase 1B.

	CA	OR	WA	NV	AZ	Baja California	British Columbia
Solid Biomass							
Solar Photovoltaic							
Solar Thermal				 (south)	 (west)		
Onshore Wind				 (south)		 (north)	
Geothermal							

Out-of-state resources were characterized based on resource types. Wind was assessed using a screening-level analysis as opposed to a more project specific analysis. This was not the case for geothermal and biomass, which generally used project level methodologies for both in state and out-of-state resources.[5] In southern Nevada and western Arizona, only pre-identified wind and solar projects were characterized, no proxy projects were created. In Baja, only border area wind resources were characterized.

For resources, such as wind, that were characterized by a screening-level process, a discount factor was applied to the identified resources. This factor takes into account the typical drop from technical potential to developable potential. The discount factor

[5] However, the focus of most of the time and effort was spent characterizing California resources – or larger resources that could be exported to California.

was based on the ratio of developable to technical potential identified in California from the results of the Phase 1A and detailed Phase 1B processes.

A more detailed discussion of out-of-state resources can be found in each resource section. British Columbia was handled separately, and is discussed below.

British Columbia Generating Resources

Pacific Gas and Electric Company (PG&E), PacifiCorp, Avista Corp., and British Columbia Transmission Corporation are proposing the development of a transmission line to access renewable generation located in British Columbia. A parallel effort being conducted by PG&E is the identification, quantification and characterization of the renewable resources in the province. RETI is including British Columbia in its modeling efforts to determine the relative feasibility of these resources.

Biomass and wind resource information for British Columbia included in the RETI analysis was provided by PG&E and is based on the assumptions developed by PG&E or its consultants. Black & Veatch has no comment on the quality of these assumptions. Geothermal resource assessments are based on data received from GeothermEx as part of the RETI review of resources. Although PG&E provided general data about geothermal potential in BC, GeothermEx's data were used because they characterize specific projects in greater detail.

An estimated 7,430 MW of installed capacity has been identified by PG&E as potentially available before 2016. Another estimated 2,500 MW could come on line after 2016.

Project-specific cost information was not provided by PG&E for wind or biomass resources, and these resources are characterized with generic project assumptions. For biomass, updated resource cost assumptions developed for Phase 1B and an individual project sizes of 35 MW are assumed for all 1,520 MW of biomass resource. For wind, updated resource cost assumptions developed for Phase 1B are used in combination with capacity factor assumptions for different wind classes. Using these assumptions, the levelized cost of energy (LCOE) for wind resources at each wind class was estimated. An average LCOE and capacity factor weighted by annual energy production is calculated for the entire BC wind resource from these results. A summary of resources in British Columbia in included on Table 3-9~~Table 3-9~~.

PG&E includes 1500 MW of long-term wind in its resource assessment that represents an off-shore wind farm. This resource was not included in the Black & Veatch analysis.

Table 3-9. British Columbia Resource Characteristics.

	Time Frame*	Project	MW	CF, %	Gen., GWh	Cap. Cost,, $/kW	FOM,$/ kW-yr	VOM, $/MWh	Fuel Cost, $/MBtu	LCOE, $/MWh
Wind	Mid	Generic	6,630	33	18,989	2,500	50	–	0	110.71
Wind	Long	Generic	1,500	40	5,311	2,500	50	–	0	86.69
Bio.	Mid	Generic	700	85	5212	4,863	91	12.45	2.46	140
Bio.	Long	Generic	820	85	6105	4,863	91	12.45	2.46	140
Geo.	Mid	Meager Creek Pebble Creek	90	80	710	3,835	–	22	0	61.78
Geo.	Long	Harrison Hot Springs	16	80	112	4,680	–	30	0	85.74
Geo.	Long	Kootenay	16	80	112	4,680	–	30	0	85.74
Geo.	Long	Mt. Cayley	45	80	355	3,900	–	25	0	66.44
Geo.	Long	Mt. Garibaldi	45	80	355	3,900	–	25	0	66.44
Geo.	Long	Okanagan	16	80	112	4,680	–	30	0	85.74
Geo.	Long	Upper Arrow	16	80	112	4,680	–	30	0	85.74

Source: Pacific Gas & Electric, GeothermEx (see Section 6).

* Mid term projects are expected to be on-line before 2016, long term projects are expected to be on-line after 2016

3.5 Transmission

The development of a transmission plan to access priority CREZs is the thrust of RETI Phase 2. RETI Phase 1 did not attempt to develop specific transmission plans for priority CREZs, rather it defined transmission requirements to access and interconnect all identified resources, and developed cost estimates for this transmission. This is required to provide a reliable estimate of the transmission cost used in the resource valuation. This section provides a discussion of the methodology and tools used by RETI to add transmission, and discusses transmission assumptions regarding California and interstate transmission.

3.5.1 Methodology

Black & Veatch designed a conceptual transmission system to interconnect all identified generating resources to the transmission system, and deliver energy produced by these resources to load centers in California, which are defined as major metropolitan areas including San Francisco / Sacramento, Los Angeles area, and San Diego. Transmission assumptions for California resources areas differed from those used for non-California resource, as RETI has substantially greater information on the transmission infrastructure within California. For out-of-state resources, RETI generally assumed these resources would interconnect to their local utility and deliver energy over the bulk transmission system.

RETI used the existing transmission system as the basis for all of its transmission planning schemas. In determining the quantity and timing of transmission additions, RETI determined need based on the capacity of identified resources requiring interconnection. After considering all available transmission capability (ATC), new transmission was added to meet the requirements. Transmission options included the addition of 230 kV, 345 kV, and 500 kV lines, with single and double circuitry for each. RETI did not physically site transmission, but for purposes of cost estimation transmission additions were aligned to parallel existing transmission right-of-way (ROW) wherever possible in order to minimize new ROW. Where new transmission ROW was required, known physical barriers such as mountains and black-out areas were considered when estimating the transmission line distance. This analysis did not include the rigorous siting criteria required to site new ROW.

Transmission Additions

Transmission is added to meet a resource's (or resource area's) maximum potential generating capacity, assuming that all resources are simultaneously deliverable. This likely overstates the transmission requirements, but is appropriate for this analysis since the actual mix of generating resources on a line is unknown. Further, certain generators may elect "interruptible" transmission services where the generator may be curtailed at certain times in exchange for using under-utilized transmission capacity at a low cost. This will be situation specific and it would be difficult to assume that resources are constructed that are not available to meet peak demand.

Transmission Reliability Criteria

The Phase 1 RETI analysis did not include load flow modeling for system reliability analyses, nor did it attempt to quantify the ancillary service requirements necessary to interconnect a substantial quantity of renewables to the grid. It is anticipated the results of this analysis will form the basis of the initial load flow studies in Phase 2 of RETI.

Transmission Modeling Tools

The RETI transmission analysis was conducted using a variety of modeling tools including ArcGIS, AutoCAD and Excel. ArcGIS was utilized to identify resource locations, land characteristics and map the existing transmission system. Using the spatial information and land characteristics identified in ArcGIS, AutoCAD was used to develop a transmission schema for each resource and CREZ. The schema was then analyzed in Excel to develop costs and allocate transmission costs for each project. Transmission costs were then adjusted in the cost of generation model and the CREZ's were again re-defined. This iterative process was conducted until the final CREZ's discussed in Section 4 were identified.

3.5.2 California Transmission

As part of the CREZ identification, valuation and ranking process RETI included the likely cost of the transmission necessary to deliver a resource's energy to a load center. Where existing or anticipated transmission could be used to deliver energy to the load center, there was limited transmission cost. Where incremental transmission was required to deliver this energy, RETI included this cost in the project economics. This section identifies the process used to identify the existing available transmission capability and assess new transmission capability requirements.

Existing System Available Transfer Capability

RETI first assessed the existing transmission system to determine the available capacity prior to adding additional capacity on the system. To identify the current available transfer capability (ATC) of the CAISO-controlled grid, RETI used Year 2007 Transmission Ranking Cost Report (TRCR) information prepared by California IOUs. In these reports the IOUs identify levels of ATC on their respective systems and estimate the upgrade costs to develop this transmission capacity. RETI included all "zero-cost" ATC identified by the IOUs in the base case. RETI did not use the TRCR cost estimates for upgrading existing lines, rather it used Black & Veatch cost estimates for developing incremental transmission. This was necessary to insure consistent cost assumptions were used in developing incremental transmission costs.

PG&E's TRCR provided transmission capacity at major substations on its system. The report identified ATC in several areas within the system, though these are not necessarily areas with substantial renewable development opportunities. PG&E identifies 1500 MW of ATC at the Gates substation, which could potentially be used by renewable resources in the Central Coast, particularly Carrizo Plains. SCE's TRCR identified ATC at an area level rather than at the substation level. Per the TRCR, SCE identified no "zero-cost" ATC. SDG&E provided ATC at a "cluster" (or area) level, and identified substantial ATC in the San Diego Coastal area but no ATC in the eastern portions of the service area.

Publicly Owned Utilities (POUs) are not required to publicize information regarding ATC on their systems. Anecdotal evidence indicates there is little ATC on these transmission systems. RETI assumed no ATC for POU transmission in the base case.

Approved Transmission

There is a substantial amount of proposed transmission at various stages of development currently. RETI cannot ignore this, as at least a portion of this will be developed. In Phase 1A RETI stakeholders approved criteria for the inclusion of proposed lines in the analysis. These criteria identified the conditions under which proposed transmission would be assumed to be available. If proposed transmission has been approved for development by the CAISO, or by the appropriate decision-maker (i.e. City Council or Publicly Owned Utility Board of Directors) for a non-CAISO jurisdictional line, the transmission would be assumed to be available to transmit energy from renewable resources at its proposed availability date. Table 3-10~~Table 3-10~~ summarizes the approved transmission projects assumed to be available in the base case.

Table 3-10. Approved Transmission .

Project Name	Owner	Year Available
Tehachapi 1-3	SCE	2011
Tehachapi 4-11	SCE	2013
Devers-Palo Verde 2	SCE	2013
Sunrise	SDG&E	2012
Green Path	IID	2011

Allocation and Cost of Existing and Approved Transmission

While no transmission is “free”, the capital costs associates with existing and approved transmission is considered as a sunk cost by RETI. Accordingly, RETI assumed zero transmission cost for resources using these transmission resources.

The determination of which projects were granted free transmission was based on the value of the individual resource. Resources with the lowest ranking cost at the point of interconnection were considered most likely to be developed and were given priority to the free transmission. Once all free transmission was allocated, all other projects were assigned transmission costs based on the incremental cost of transmission to serve these resources. The amount of free transmission at each transmission line/interconnection point and the CREZs that could access this transmission are included in Table 3-11~~Table 3-11~~.

Table 3-11. Available Transfer Capability By CREZ

Transmission Line/ Interconnection Point	ATC (MW)	Eligible CREZs
Tehachapi 1-3 Tehachapi 4-11	4350	Fairmont Tehachapi Kramer (North) Inyokern Owens Valley Central Nevada
Palo Verde-Devers 2	1200	Riverside East Arizona
Gates Substation	1500	Carrizo North Carrizo South Cuyama Santa Barbara
Tesla Substation	2000	Solano
Sunrise & Green Path	2200	San Diego South San Diego North Central Imperial North Imperial East Imperial South Baja

The allocation of free transmission is an economic advantage for the resources in the affected CREZs. For this reason, a sensitivity scenario was run in Section 5 that explores the impact to CREZs if they are allocated full costs for transmission that is approved but not yet built.[6]

Incremental Transmission Additions

Transmission was added to connect the entire capacity of a resource or resource area. This includes the addition of new and/or upgraded facilities to meet expected requirements, including the following:

[6] The result of this sensitivity study was that only one of the top-ranking CREZs, Riverside East-A, is significantly impacted by this assumption.

- **Collector substations.** Many CREZs require upgrades of existing substations, or the addition of new substations, to allow resources in a CREZ to interconnect to the grid.
- **Trunk lines.** New transmission was added to enable collector points to interconnect to the existing high-voltage grid if the collector point is not on the current grid or if the line requires upgrading to deliver the energy and capacity to the grid.
- **Network costs.** The cost of delivering the energy to primary substations located in the identified load centers.

RETI did not include cost estimates for upgrades to the distribution system that may be required. Recognizing that the distribution system may require changes that will increase the total transmission cost, it is impossible to reliably estimate these costs without load flow modeling.

Generation Tie Lines, Trunk Lines and Environmental Exclusion Areas

Conceptual linkages representing generation tie-lines (gen-ties) were drawn from projects to hypothetical collector stations. Trunk lines were then drawn to load centers. These gen-ties and trunk lines are only conceptual representations of linkages between projects and CREZ substations. They were drawn to estimate distances, so that transmission costs could be estimated.

Because they do not represent actual routes, gen-ties and trunk lines were generally drawn point to point without respect for environmental exclusions. As a result, these lines may be shown crossing through environmental exclusion areas on RETI maps. This does not matter because these are conceptual, representative linkages, rather than actual or proposed routes.

3.5.3 Out-of-State Transmission

The transmission methodology use for non-California resources differed from the methodology used for California resources for several reasons. First, the ATC of lines outside California is not available to RETI. Next, the location of resources that may deliver energy to California is generally not precisely known, hence it would be impossible to develop meaningful transmission costs for those projects. Finally, anecdotal evidence suggests there is little bulk power transfer capability for exporting power in the West, and that most renewable energy will require incremental transmission capacity to deliver energy to California.

North Out-of-State Resource Areas (BC, WA and OR)

Discussed in detail in the resource sections of this report, there are substantial renewable resources in Oregon, Washington and British Columbia, Canada that have the potential to deliver energy to California. There is however, currently little or no available transmission to deliver energy from this resource area to California.

To increase this import capacity, Pacific Gas & Electric Company (PG&E), PacifiCorp, Avista Corp. and the British Columbia Transmission Corporation have proposed the Canada/Pacific Northwest – Northern California Transmission Line Project. As designed, the line has the capability to deliver an incremental 3,000 MW of resources from the North OOS resource area to California. In November, 2007 the WECC Technical Analysis Committee (TAC) conducted a Regional Planning Review for the proposed line, which evaluated 13 transmission alternatives for adding new transmission from British Columbia to California. It recommended a transmission strategy that would allow for the transmission of up to 3,000 MW of new generation from Canada to California or 1,500 MW of new generation from Canada and 1,500 MW of generation from Washington/Oregon. The TAC recommended route extends from Selkirk, British Columbia southward to the Tesla/Tracy substations in Northern California, with intermediate connections at McNary, WA and Grizzly, OR. The TAC study estimated the total cost of the preferred alternative to be $4.8 billion. These costs, by transmission segment, are provided on Table 3-12~~Table 3-12~~.[7]

Table 3-12. Transmission Capital Cost - WECC Technical Advisory Committee

Segment	$/kW
Selkirk, Canada – WA	1,734
WA (Mid-C/McNary) – Grizzly, OR	1,289
Grizzly, OR – Tesla/ Tracy, CA	656

RETI used the costs identified by the TAC for incremental transmission from the North OOS resource area. To develop a transmission cost for BC resources, RETI assumed that the entire line would be used to transmit BC resources, with the total cost of development allocated to these resources. To develop cost estimated for Washington and Oregon resources, RETI assumed a pro-rata portion of the BC cost based on segment mileage, including the cost of all required network upgrades.

[7] Sea Breeze Pacific Regional Transmission System filed comments for an alternate undersea cable proposal that they claim would significantly reduce costs and environmental impacts.

Nevada Resource Areas

The Nevada resource area included three distinct regions with different transmission interconnections and costs. The division of Nevada resources is required because the transmission solution necessary to transmit energy from each region is distinctly different. The Sierra Pacific Power Company, which operates in Northern Nevada, and Nevada Power Company, which operates in southern Nevada, are very weakly linked electrically and effectively operate as separate systems. Additionally, resources in Central Nevada are physically remote from either system. The sub-areas and their respective transmission requirements are discussed below.

Northern Nevada – This includes the area roughly from Reno north to the Idaho border. For RETI it was assumed that these resources would interconnect to the Sierra Pacific electric grid. Energy from these resources would travel north from Reno using an existing 230 kV line, with energy deliveries to California flowing though the South Lassen CREZ. Like the Northern California resource area, energy from Northern Nevada would be delivered to the San Francisco/Sacramento metropolitan area.

Central Nevada – This region includes the western portions of Mineral and Esmeralda counties. This area is remote from the existing Nevada transmission infrastructure, but near the Pacific Intertie, a direct current (DC) transmission line that extends from northern Oregon to Southern California. RETI assumed that a new 345 kV alternating current (AC) transmission line would be built to interconnect these facilities directly to the California grid. This line would extend from western Mineral County and interconnect to the California electric grid at the Control substation in Inyo County, California.

Southern Nevada - Southern Nevada resources interconnect to California grid in two ways. Several wind and solar facilities are currently proposed for development in Nevada near the California border, and at least some of these facilities propose to interconnect directly to the California grid. RETI modeled the interconnection cost for these facilities assuming a California grid interconnection, and these resources are not subject to the import caps for southern Nevada / Arizona resource imports.

In addition to the border resources, RETI identified a substantial quantity of solar and wind resources located in southern Nevada. These resources are presumed to interconnect to the Nevada Power Company transmission system, with energy transmitted to the CAISO grid at the Mead substation in Southwestern Nevada. These resources would be subject to a transfer limit of 2,500 MW.

3.5.4 South Out-of-State Resource Areas (AZ and Baja, Mexico)

Arizona

The CAISO identifies the Palo Verde substation located in northwestern Arizona as the CAISO transmission access point to California. For resources located in Arizona, RETI assumed the capital cost of transmission to include the cost of interconnecting identified resources directly to the Palo Verde substation. The estimated costs for delivering energy from the Palo Verde substation to Los Angeles was based on a route following the proposed Devers-Palo Verde 2 line.

Baja California Norte, Mexico

Several wind resources were identified along the U.S. / Mexico border in Baja, Mexico. Physically located in Mexico, these resource are anticipated to interconnect to the transmission grid at the Imperial Valley substation located in Imperial County, California. Transmission costs for these resources are consistent with other resources interconnecting to the grid at the Imperial Valley substation.

3.6 Resource Valuation

RETI evaluated a Rank Cost for each project. Rather than comparing projects on the levelized cost of generating energy 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.

3.6.1 Generation Cost

The cost of generation is calculated as a levelized cost of generating power over the life of the resource. The cost of generation is calculated on a $/MWh basis, allowing the resource in question to be compared with disparate resources types with different costs and operating over different time periods. It is calculated using a simple financial model that considers the project from the point of view of a developer, including the developer's direct costs, charges and incentives, as well as an expected rate of return on the equity. Specifically, it considers:

- Operations and maintenance costs
- Fuel costs (as appropriate)
- Cost of equity investment in capital
- Cost of financing capital
- Taxes, including investment and production credits

Other costs, such as insurance, property taxes, development fees, interest during construction, and debt service reserve funds are included within these major categories. Black & Veatch has strived to make the model as simple as possible while still maintaining an appropriate level of accuracy for comparing the relative generation cost of different projects employing different renewable energy technologies. The simplifying assumptions allow the model to serve its analytical purpose and still be streamlined enough to evaluate hundreds of projects. Because of the simplifications, the model is not intended to simulate the exact financial performance of any one project. Use of the model in this way would be inappropriate.

Line items and calculations in the Cost of Generation Calculator are outlined below. The Excel model can be downloaded from the RETI website. A screenshot of the calculator is included as Figure 3-3~~Figure 3-3~~.

- **NPV for Equity Return**: A cost of equity is assumed as part of the financial assumptions. This number is treated as a hurdle which the project must reach. The project must generate sufficient income from power sales to obtain this return on equity. The Net Present Value (NPV) for Equity Return discounts all cash flows associated with the project by this prescribed return to generate a present value. If this metric is zero, the project is returning exactly the prescribed amount to equity investors. Higher values mean that the project generates too much money, and lower values mean that it does not generate enough.
- **Levelized Cost of Generation**: The actual cost of generation used in the model escalates over time. The levelized cost of generation is the constant cost (no escalation) that produces the same net present value as the actual modeled costs of generation over the life of the project. This single metric is the main output of the model.
- **Annual Generation**: The annual generation for the project is calculated based on an 8,760 hour year, the project capacity and the assumed capacity factor.
- **Cost of Generation**: The Year one cost of generation is chosen such that the NPV for Equity Return is zero. Costs of generation in later years are escalated by the assumed value.
- **Fixed Operations and Maintenance**: Fixed O & M is calculated from the assumed dollars per kilowatt of capacity per year, the project capacity and the assumed escalation value.

- **Variable Operations and Maintenance**: Variable O & M is calculated from the assumed dollars per megawatt-hour, the annual generation and the assumed escalation value.
- **Fuel Cost**: Annual generation, net plant heat rate, fuel cost and annual escalation of fuel cost determine the annual fuel cost for the project.
- **Debt Service**: Mortgage-style principal and interest payments are calculated for the proportion of the project that is assumed to be financed, the debt rate and the term of the financing.
- **Tax Depreciation**: Depreciation of project assets are calculated for tax purposes. These numbers are based on the Modified Accelerated Cost Recovery System (MACRS) depreciation schedules detailed in the table at the bottom of the spreadsheet. The percent of capital cost to be depreciated is also an input. For simplification, only one depreciation schedule is assumed to apply to a project.
- **Production Tax Credit (PTC)**: The production tax credit is modeled using three parameters: the dollars per megawatt-hour credit, the annual escalation of the credit, and the duration of PTC availability in years.
- **Investment Tax Credit (ITC)**: ITC eligible projects are credited the prescribed percent of their capital costs in year one.
- **Taxes**: Projects pay an all-in combined tax rate on their taxable income (operating revenue less operating expenses and depreciation) and are credited for applicable tax credits (PTC and ITC).
- **Total**: These are the cash flows associated with the project, including the equity investment portion of the overall capital costs (accounted for as a single value in year zero).
- **Solving for Year One Cost of Generation**: Since NPV for equity return is linear with respect to year one cost of generation, the relationship can be defined by two points. In the “Calculation” box at the top of the spreadsheet, two cost scenarios ($0 and $5) are run using Excel’s TABLE() function. The equation for the resulting line is solved for when NPV for equity return is zero and the value is set as the year one cost of generation.

Cost of Generation Calculator

All inputs are in blue.

Technology Assumptions	
Project Capacity (MW)	100
Capital Cost ($/kW)	$2,400
Fixed O&M ($/kW)	$50
Fixed O&M Escalation	2.5%
Variable O&M ($/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%

Financial/Economic Asumptions	
Debt Percentage	60%
Debt Rate	7.5%
Debt Term (years)	15
Economic Life (years)	20
Depreciation Term (years)	5
Percent Depreciated	100%
Energy Price Escalation	2.5%
Tax Rate	40%
Cost of Equity	15%
Discount Rate	10.5%

Incentives	
PTC ($/MWh)	$21
PTC Escalation	2.5%
PTC Term (years)	10
ITC	0%

Outputs	
NPV Equity Return	$0
LCOE	$81.97

Calculation		
Cap Cost		##########
	0	
	0	-79935527.9
	5	-74177547.4
slope		1151596.1

5

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Annual Generation (MWh)		306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600	306,600
Power Price		$69.41	$71.15	$72.93	$74.75	$76.62	$78.53	$80.50	$82.51	$84.57	$86.69	$88.85	$91.08	$93.35	$95.69	$98.08	$100.53	$103.04	$105.62	$108.26	$110.97
Total Operating Revenue		**$21,281,969**	**$21,814,019**	**$22,359,369**	**$22,918,353**	**$23,491,312**	**$24,078,595**	**$24,680,560**	**$25,297,574**	**$25,930,013**	**$26,578,263**	**$27,242,720**	**$27,923,788**	**$28,621,883**	**$29,337,430**	**$30,070,866**	**$30,822,637**	**$31,593,203**	**$32,383,033**	**$33,192,609**	**$34,022,424**
Fixed O&M		$5,000,000	$5,125,000	$5,253,125	$5,384,453	$5,519,064	$5,657,041	$5,798,467	$5,943,429	$6,092,014	$6,244,315	$6,400,423	$6,560,433	$6,724,444	$6,892,555	$7,064,869	$7,241,491	$7,422,528	$7,608,091	$7,798,294	$7,993,251
Variable O&M		$0	$0	$0	$0	$0	$0	$0	$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	$0	$0	$0	$0	$0	$0	$0
Operating Expenses		**$5,000,000**	**$5,125,000**	**$5,253,125**	**$5,384,453**	**$5,519,064**	**$5,657,041**	**$5,798,467**	**$5,943,429**	**$6,092,014**	**$6,244,315**	**$6,400,423**	**$6,560,433**	**$6,724,444**	**$6,892,555**	**$7,064,869**	**$7,241,491**	**$7,422,528**	**$7,608,091**	**$7,798,294**	**$7,993,251**
Interest Payment		$10,800,000	$10,386,498	$9,941,983	$9,464,130	$8,950,437	$8,398,218	$7,804,582	$7,166,424	$6,480,403	$5,742,931	$4,950,149	$4,097,908	$3,181,749	$2,196,878	$1,138,142	$0	$0	$0	$0	$0
Principal Payment		$5,513,362	$5,926,864	$6,371,379	$6,849,232	$7,362,925	$7,915,144	$8,508,780	$9,146,939	$9,832,959	$10,570,431	$11,363,213	$12,215,454	$13,131,613	$14,116,484	$15,175,220	$0	$0	$0	$0	$0
Debt Service		**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$16,313,362**	**$0**	**$0**	**$0**	**$0**	**$0**
Tax Depreciation		$48,000,000	$76,800,000	$46,080,000	$27,648,000	$27,648,000	$13,824,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income		($42,518,031)	($70,497,479)	($38,915,739)	($19,578,229)	($18,626,190)	($3,800,664)	$11,077,511	$12,187,721	$13,357,595	$14,591,017	$15,892,148	$17,265,447	$18,715,690	$20,247,997	$21,867,855	$23,581,146	$24,170,675	$24,774,942	$25,394,315	$26,029,173
PTC		$6,438,600	$6,745,200	$6,745,200	$7,051,800	$7,051,800	$7,358,400	$7,358,400	$7,665,000	$7,971,600	$7,971,600	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
ITC		$0																			
Taxes		**($23,445,812)**	**($34,944,192)**	**($22,311,496)**	**($14,883,092)**	**($14,502,276)**	**($8,878,666)**	**($2,927,396)**	**($2,789,911)**	**($2,628,562)**	**($2,135,193)**	**$6,356,859**	**$6,906,179**	**$7,486,276**	**$8,099,199**	**$8,747,142**	**$9,432,459**	**$9,668,270**	**$9,909,977**	**$10,157,726**	**$10,411,669**
Total	***(96,000,000)***	***23,414,420***	***35,319,848***	***23,104,378***	***16,103,630***	***16,161,161***	***10,986,857***	***5,496,126***	***5,830,694***	***6,153,198***	***6,155,780***	***(1,827,924)***	***(1,856,186)***	***(1,902,199)***	***(1,967,686)***	***(2,054,508)***	***14,148,688***	***14,502,405***	***14,864,965***	***15,236,589***	***15,617,504***

MACRS Depreciation Schedules																				
5	0.2	0.32	0.192	0.1152	0.1152	0.0576	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0.1429	0.2449	0.1749	0.1249	0.0893	0.0892	0.0893	0.0446	0	0	0	0	0	0	0	0	0	0	0	0
15	0.05	0.095	0.0855	0.077	0.0693	0.0623	0.059	0.059	0.0591	0.059	0.0591	0.059	0.0591	0.059	0.0591	0.0295	0	0	0	0
20	0.0375	0.07219	0.06677	0.06177	0.05713	0.05285	0.04888	0.04522	0.04462	0.04461	0.04462	0.04461	0.04462	0.04461	0.04462	0.04461	0.04462	0.04461	0.04462	0.04461

Figure 3-3. Example Generation Cost Calculation for a Wind Project.

3.6.2 Transmission Costs

The transmission cost for each project is unique and determined based on the project size, location and the specific transmission path required to deliver the energy to a California load area. Transmission costs in RETI includes a fixed cost component representing the expected cost to develop the transmission line, and a variable component. Generation resource interconnection costs (or "gen-tie" costs) are borne by the generating facility and are considered as part of the capital cost of the resource rather than part of the transmission cost.

Fixed Costs

Most facilities require some incremental transmission investment. The size of this transmission investment will depend on the location of the resource, and may include the following elements:

- **Collector substations.** Many CREZs require upgrades to existing substations or the addition of new substations to allow resources in a CREZ to interconnect to the grid.
- **Trunk lines.** This includes transmission necessary to interconnect collector points to the existing high-voltage grid if the collector point is not on the current grid or if the line requires upgrading to deliver the energy and capacity to the grid.
- **Network costs.** The cost of delivering the energy from the point of transfer to the transmission grid to the terminus substation located in the identified load centers.

RETI does not include cost estimates for upgrades to the distribution system that may be required. Recognizing that the distribution system may require changes that will increase the total transmission cost, without load flow modeling it is impossible to reliably estimate these costs.

Variable Costs

Projects are assigned costs per megawatt-hour delivered to the transmission system. For California projects, the CAISO's Transmission Access Charge (or TAC) was used as a proxy for all resources.

Out-of-state resources that do not directly interconnect to the California grid will likely face pancake transmission costs, having to pay a wheeling fee to the interconnecting utility as well as paying the CAISO's TAC charge. The wheeling cost may be highly variable depending on the location of the resource and the transmission interconnection agreement between the generator and the transmission host. As a simplifying assumption RETI used a wheeling cost of $2.00/MWh in addition to the

CAISO TAC charge. The variable transmission costs applied to projects in each resource area is detailed in Table 3-13~~Table 3-13~~.

Table 3-13. Variable Transmission Costs

Location	Cost ($/MWh)
California	3.75
OOS-North (WA/OR/B.C.)	5.75
Nevada – North	5.75
Nevada – Central	3.75
Nevada – South	3.75
Arizona	5.75
Baja	3.75

Line Loss Factors

The amount of energy loss due to transmission for each resource depends on several factors including line size, line loading, and distance from resource to delivery point. Line losses are dynamic and are calculated by the CAISO on an hourly basis. The CAISO does not forecast line losses for planning purposes, so RETI used CPUC guidance on line losses. CPUC Decision 07-09-040 directed Qualifying Facilities to the line loss assumptions provided in CPUC Decision 01-01-007. This decision provides "Renewable qualifying facilities (QFs) paid under the Section 390 (b) formula shall receive a transmission loss factor that is the greater of GMMQF/GMMSYS or 0.95." Accordingly, RETI assumed all California renewable resources will have a 5 percent loss.

For out-of-state resources, RETI applied formulaic loss factors. Losses are proportional to line length and the square of the current. For line loss calculation purposes RETI assumed that all lines would be 500 kV, and loaded at approximately 70 percent. Using this assumption, calculated losses were 0.20 MW per mile. These losses were applied to each project based on the point of interconnection to the CAISO delivery point. Similar to variable costs, RETI assumed that losses would pancake, so an additional 5 percent loss factor for California losses was applied to out-of-state resources.

3.6.3 Energy Value

An integral component of the resource valuation is the value of energy delivered by the generating resources. The Phase 1A report describes the calculation methodology for energy values; this section focuses on the energy price forecast used.

The energy value is intended to reflect the marginal cost of generation in the region where the resource is located. As RETI values the capacity of a resource independent of the energy price, it is appropriate to consider only the marginal cost of generation in determining the energy value of a resource.

Three energy price forecasts were developed in order to allow a plausible range of future energy costs, including a reference, high, and low forecast. The forecasts were developed by Ventyx using the ProSym production cost model, incorporating assumptions developed by the CEC for the 2007 IEPR proceeding. Specifically, the energy price forecasts are based on the CEC's 2007 IEPR "Scenario 1B" forecast. This was selected by the RETI Phase 1B Working Group for several reasons:

- This scenario reflects RETI's assumptions regarding the achievement of RPS, implementation of the CSI, energy efficiency goals and demand response programs.
- Assumptions used in the CEC's 2007 IEPR forecast are well documented and have been publicly vetted.
- The forecast was prepared during summer 2007, and most assumptions underlying the forecast are substantively current.

Differences from the CEC IEPR Assumptions

The forecasts are based on the CEC IEPR, but differ in two major respects – the fuel price assumptions and the addition of a carbon adder.

<u>Fuel Prices:</u>

The CEC IEPR used fuel price forecasts prepared by Ventyx current as of summer 2007. Since then, fuel prices have been extremely volatile, making the selection of an appropriate gas forecast difficult. RETI used the Ventyx high fuel price forecast prepared for the CEC as the reference case assumption in RETI, and used the CEC IEPR base case forecast as the RETI low forecast. For the high fuel price case, RETI took a NYMEX annual stream of forward market prices as of June 27 (July foreword contract closing date) and escalated these at 1 percent annual inflation (real).

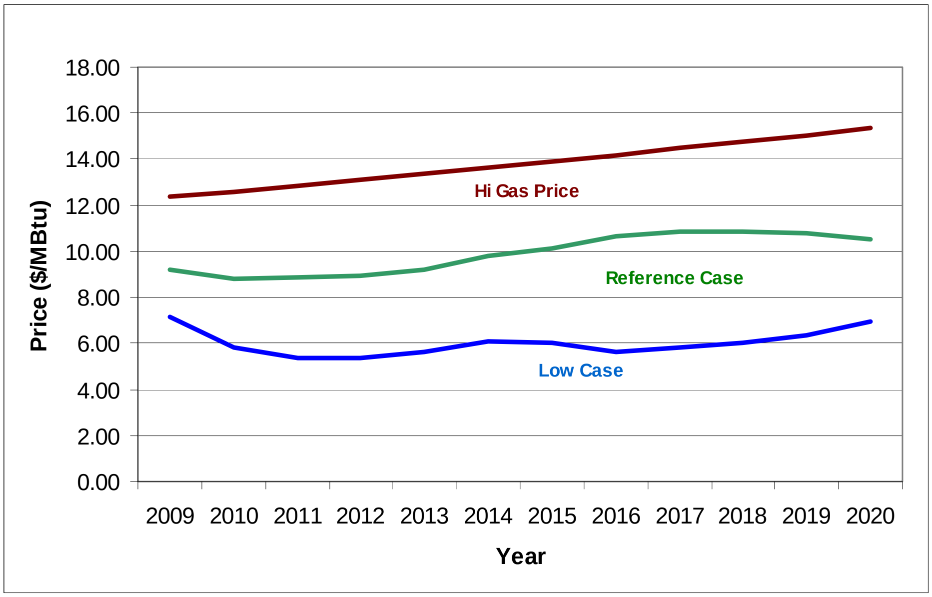


Figure 3-4. Energy Forecast Gas Prices ($/MBtu).

Table 3-14. Energy Forecast Gas Prices ($/MBtu)

Year	Reference Case Gas Prices	Low Case Gas Prices	High Case Gas Prices
2009	9.23	7.17	12.34
2010	8.78	5.82	12.59
2011	8.88	5.36	12.84
2012	8.94	5.34	13.10
2013	9.20	5.61	13.36
2014	9.78	6.09	13.63
2015	10.13	5.99	13.90
2016	10.66	5.60	14.18
2017	10.82	5.83	14.46
2018	10.84	6.02	14.75
2019	10.78	6.36	15.05
2020	10.55	6.96	15.35

Carbon Adder:

The CEC IEPR energy price scenarios did not include a Carbon adder in the dispatch price of fossil resources. RETI will include a carbon adder in all scenarios starting in 2012 thought the forecast period. The value is based on the CPUC's 2007 MPR proceeding adopted value.

The reference case and other forecast specifications are detailed on Table 3-15~~Table 3-15~~ below.

Table 3-15. Energy Forecast Assumptions

Assumption	CEC IEPR	RETI Reference Case	RETI Low Case	RETI High Case
Modeling	CEC sensitivity 1B	CEC sensitivity 1B	CEC sensitivity 1B	CEC sensitivity 1B
Gas Price	GED Base fuel price for CEC , 2007	GED High fuel price for CEC , 2007	GED Base fuel price for CEC , 2007	2008 CPUC MPR gas price forecast (w/CEC high fuel price forecast for other fuels)
Carbon Cost	N/A	CPUC MPR adder	CPUC MPR adder	CPUC MPR adder

Transmission Costs for Distributed Solar Photovoltaic Costs

Black & Veatch assumed that the 20 MW distributed solar PV projects characterized in this report would not require large transmission system upgrades. The only transmission cost included for these resources is the CAISO TAC and the project interconnection. These projects are assumed to be connected to smaller substations on the 50-200 kV transmission system. Large scale deployment of hundreds of such systems would likely require system upgrades and reinforcements; however, this was beyond the scope of this study.

3.6.4 Capacity Value

The capacity value of a generating resource is based on its ability to provide dependable and reliable capacity during peak periods when the system requires reliable resources for stable operation. Resources that can provide firm capacity will have a higher capacity value than resources that cannot. In California capacity value is assessed by the resource adequacy value. Current resource adequacy practice considers the average resource capacity factor during the 12:00 p.m. – 6:00 p.m. period year-round. However, based on guidance from the Phase 1A Working Group, RETI will limit this to determination of capacity factor during the summer months (June-September). For the purposes of RETI, this average summer peak capacity factor is known as the "capacity credit."

The baseline value of capacity is the cost of the next most likely addition of low-cost capacity, defined as the fixed carrying costs of a simple cycle gas turbine generator. This includes the capital costs, fixed operations and maintenance costs, and other fixed charges associated with the gas turbine generator capacity, expressed as a dollar per kilowatt per year ($/kW-year). The capacity value does not include variable costs, such as fuel purchases.

This baseline capacity value is adjusted for each project based on its capacity credit. Resources that are more "firm" receive a higher capacity credit. As discussed previously, the capacity credit is the average capacity factor for a project during the period from 12:00 p.m. – 6:00 p.m. during summer months. For all projects, this is derived from the projected 24 hour by 12 month generation profile for the resource, described in Section 6 for each resource.

There are other methods to calculate the capacity credit, such as the effective load carrying capability (ELCC), that might be more accurate. However, basing the capacity credit on the current resource adequacy approach is relatively straightforward from an analytical perspective and also consistent with current regulatory practice.

The example Table 3-16~~Table 3-16~~ shows the capacity value calculation for three hypothetical projects based on a hypothetical baseline capacity value of $100/kW-year and hypothetical capacity factors. This example is included for illustrative purposes only. The capacity value in dollars per kilowatt-year is calculated by multiplying the capacity credit by the baseline capacity value. The formula for calculating capacity value is:

Capacity Value =
(Capacity Credit) x (Baseline Capacity Value)

Table 3-16. Example Capacity Value Calculation.

	Wind	Solar	Biomass / Geothermal
Capacity Credit (CF in summer 12-6)	25%	90%	100%
Baseline Capacity Value ($/kW-yr)	$100	$100	$100
Capacity Value ($/kW-yr)	$25	$90	$100
Note: Hypothetical example, for conceptual illustration only.			

The baseline capacity value is the levelized fixed costs of a simple cycle gas turbine generator, owned by a merchant generator. This value is sourced from the CEC Cost of Generation report. The determination is outlined below in Table 3-17~~Table 3-17~~.

Table 3-17. Baseline Capacity Value ($2007)

Levelized Fixed Costs of a Simple Cycle Gas Turbine Generator ($/kW-yr)	
Capital & Financing - Construction	$137
Insurance	$8
Ad Valorem Costs	$7
Fixed O&M	$13
Corporate Taxes (w/Credits)	$39
Total Fixed Costs	$204

Source: CEC Comparative Cost of California Central Station Electricity Generation Technologies, CEC-200-2007-011-SF, December 2007.

3.6.5 Ranking Cost

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 ranking cost. The ranking cost is calculated using the following formula:

Ranking Costs =
Generation Cost + Transmission Cost
- Energy Value - Capacity Value

The ranking 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.

3.6.6 Consideration of Uncertainty and Sensitivities

It is very important to consider the uncertainty in the estimates used to value resources. By their very nature, these estimates include a margin of error. It would not be prudent to eliminate potential CREZs from consideration if the difference in their ranking cost is 5 percent, but the margin of error is 20 percent. For this reason, a methodology has been developed in to assess the impacts of uncertainty on the ranking process. This is described further in Section 5.

3.7 Development Timeframe

A consideration in the development of resource areas and CREZs is timing. To design, permit and construct new transmission facilities is a multi-year process, and RETI recognizes that resources and CREZs requiring new transmission may only be available in the long term. To implement this RETI segregated the study period into three timeframes based on the availability of transmission, including near-, mid-, and long-term.

Table 3-18. Resource Development Timeframe

Resource Availability	Timeframe
Near-term	2009-2013
Mid-term	2014-2016
Long-term	2017-2020

RETI assumed that resources and CREZs using existing transmission, transmission under construction and CAISO-approved transmission would be available in the near-term. Resources using transmission lines that are currently proposed but not approved by the CAISO, such as PG&E’s British Columbia line, are assumed to be available in the mid-term. New transmission, such as a new line from the Los Angeles area to Southern Nevada, was assumed to be only available in the long-term. Table 3-19~~Table 3-19~~ identifies the time frame in which resources located in each CREZ are expected to be available based on the expected availability of enabling near-term transmission.

Table 3-19. Development Timeframe by CREZ

	Timeframe	Enabling Near-Term Transmission
California CREZ		
Barstow	Mid-Long	
Carrizo North	Near	Available transmission
Carrizo South	Near	Available transmission
Cuyama	Near	Available transmission
Fairmont	Near	Tehachapi
Imperial East	Mid-Long	
Imperial North	Near	Sunrise and/or Green Path
Imperial South	Near	Sunrise and/or Green Path
Inyokern	Mid-Long	
Iron Mountain	Mid-Long	
Kramer	Mid-Long	
Lassen North	Mid-Long	
Lassen South	Mid-Long	
Mountain Pass	Mid-Long	
Needles	Mid-Long	
Owens Valley	Mid-Long	
Palm Springs	Near	Devers - Palo Verde 2
Pisgah	Mid-Long	
Riverside East	Near	Devers - Palo Verde 2
Round Mountain	Mid-Long	
San Bernardino - Baker	Mid-Long	
San Bernardino - Lucerne	Mid-Long	
San Diego North Central	Near	Sunrise
San Diego South	Near	Sunrise and/or Green Path
Santa Barbara	Mid-Long	
Solano	Near	Available transmission
Tehachapi	Near	Tehachapi
Twentynine Palms	Mid-Long	
Victorville	Mid-Long	
Non-CREZ Resources		
Non-CREZ Resources	Near	CA projects which don’t require major transmission
Out-of-State Resources		
Arizona	Near	Devers - Palo Verde 2
Baja	Near	Sunrise and/or Green Path
British Columbia	Mid-Long	
Central Nevada	Mid-Long	
Northern Nevada	Mid-Long	
Oregon	Mid-Long	
Southern Nevada	Mid-Long	
Washington	Mid-Long	

3.8 Net Short Calculation

The RETI Phase 1B analysis forecasts the demand for renewable energy in California in order to determine the quantity of new generation that must be built. This is termed the "net short" and is described in this section.

The California energy demand has been forecasted through 2020 in order to determine the incremental percentage of renewable energy required to keep the state on target to reach the proposed Renewable Portfolio Standard (RPS) target of 33 percent by 2020.

California was among the first states to enact a renewable portfolio standard and currently has one of the most aggressive renewable energy portfolio requirements in the country. California's RPS requires that 20 percent of electric energy delivered to consumers by load serving entities (LSEs) be generated from renewable resources by 2010 (2013 with flexible compliance).[8] The Governor and the state's Energy Action Plan have endorsed a further goal of 33 percent renewables by 2020, in part, as a possible strategy for meeting the greenhouse gas emission reduction requirements of AB 32.[9] The RETI analysis assumes to meet the 33 percent standard.

Although most electric energy used in California is delivered to consumers by LSEs, some consumers generate electricity themselves. Self-generation includes electricity from photovoltaic (PV) systems installed on urban roof-tops, for example. Since the RPS is a requirement on energy delivered by LSEs rather than on total electric energy use, PV and other renewable self-generation is not counted toward RPS compliance under current rules.

Electric energy generated from PV installations is counted toward RPS compliance if the energy is sold to LSEs for resale to consumers or if the installation is owned by an LSE. It has also been proposed that LSE's be allowed to purchase "renewable energy credits" (RECs) from renewable self-generators. At the present time, however, CPUC rules do not permit the use of RECs for RPS compliance.

It has been noted that publicly owned utilities are not subject to the same RPS requirements as investor owned utilities. However, most have developed similar renewable goals, and it has been agreed that the state's requirements for investor owned utilities were an appropriate proxy for all load-serving entities.

[8] SB 1078 established an RPS of 20% by 2017. The Energy Action Plan, adopted by the Commission and the California Energy Commission (CEC) in May 2003, accelerated the completion date to 2010. SB 107, passed in 2006, codified that policy.
[9] Assembly Bill 32, Ch. 488, Stats. 2006. Executive Order S-3-05, signed by the Governor on June 1, 2005 establishes greenhouse gas emission reduction goals for California and identifies acceleration of the renewable energy goals to 33% of energy sales by 2020 as one strategy to meet those goals.

3.8.1 California Load Growth

The basis for RETI's revised projections of ~~To project~~ future ~~renewable~~ RPS requirements~~,~~ ~~RETI~~ is ~~using~~ the CEC ~~statewide load~~ forecast of sales by LSEs prepared as part of the 2007 Integrated Energy Policy Report (2007 IEPR), which extends through 2018.[10] The forecast was extended to 2020 in a filing at the CPUC by the CEC in the Long Term Procurement Proceeding.[11] However, the CEC forecast assumed that the California Go Solar Program described below would not meet its goals. In this revised report RETI assumes that the goals of the Go Solar program will be met and has adjusted the CEC forecast of LSE sales downward accordingly. ~~LSE sales for the years 2019 and 2020, the 2018 statewide total electric load was inflated 1.3 percent per year, which is the average annual growth rate from 2007-2018 in the CEC forecast.[12]~~ This forecast incorporates CEC staff's expectations for energy efficiency~~ and behind-the-meter generation~~. If higher~~-~~ levels of energy efficiency ~~and behind-the-meter generation~~ are achieved, it will reduce the net short commensurately.

3.8.2 RPS Assumptions

RETI considers three RPS target points for generation in the analysis. The near term target is the 20 percent requirement, which RETI assumes, with flexible compliance, will be met in 2013. The ultimate target is 33 percent renewables by 2020. Additionally, an intermediate goal has been set for 2016, which lies on a straight-line interpolation. Table 3-20 shows the RPS requirement milestones. Figure 3-5~~Figure 3-5~~ shows the annual RPS requirement, with the initial renewable contribution of 10.9 percent in 2006.

Table 3-20. RPS Requirements

Year	~~CA Load~~LSE Sales (GWh)	RPS Requirement (%)	RPS Requirement (GWh)
2013	~~309,148~~281,346	20%	~~61,830~~56,269
2016	~~320,178~~290,494	26%	~~83,246~~74,283
2020	~~335,644~~301,973	33%	~~110,763~~99,651

[10] California Energy Commission, "California Energy Demand 2008-2018: Staff Revised Forecast, FINAL Staff Forecast, 2nd Edition", Publication # CEC-200-2007-015-SF2, November 2007, Form 1.1c - Statewide. Note that the 2007 final forecast is significantly higher than the draft forecast. The forecast includes energy efficiency and demand side measures that the CEC expects to occur.

[11] Get Reference from CEC if possible.

~~[12] California Energy Commission, "California Energy Demand 2008-2018: Staff Revised Forecast, FINAL Staff Forecast, 2nd Edition", Publication # CEC-200-2007-015-SF2, November 2007, Form 1.1c - Statewide. Note that the 2007 final forecast is significantly higher than the draft forecast. The forecast includes energy efficiency and demand side measures that the CEC expects to occur.~~

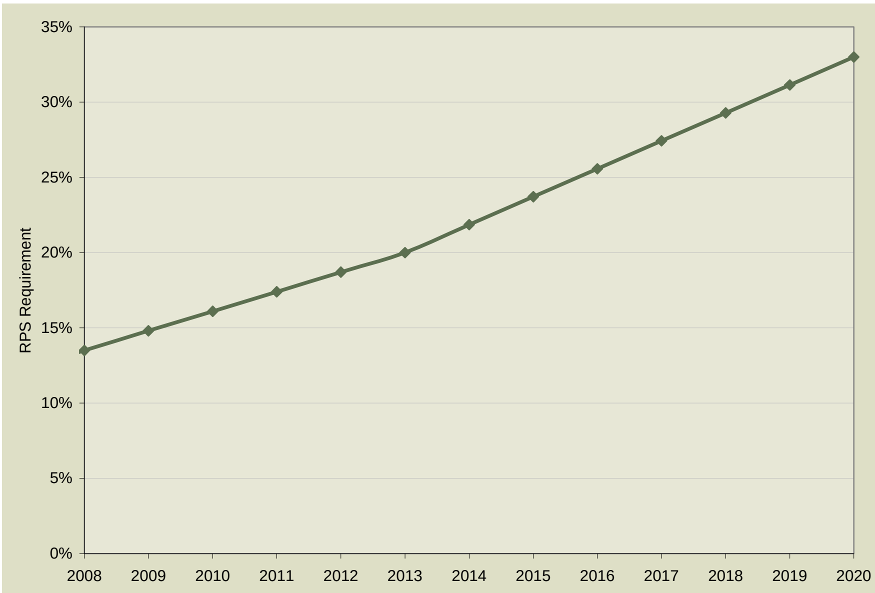


Figure 3-5. Annual RPS Requirement.

3.8.3 Existing Resources

Currently, approximately 12 percent of California's total electric energy requirements are satisfied with RPS-eligible generation as documented by Net System Power Report for 2007.[13] Investor owned utilities serve a somewhat higher percentage of the load with renewable energy, but this is tempered by lower quantities by publicly owned utilities. Table 3-21 provides a breakdown of the existing renewable capacity by resource type.

Generation from existing renewable resources is assumed to stay constant during the RETI study period.

Table 3-21. Existing RPS-Eligible Resources.

Resource	Energy Delivery (GWh)	Percent of California Energy
Biomass	6,236	2.1%
Geothermal	13,439	4.5%
Small Hydro	8,393	2.8%

[13] California Energy Commission, "2007 Net System Power Report: Staff Report", Publication # CEC-200-2008-002, April 2008.

Solar Wind	675 6,802	0.2% 2.3%
Total	35,545	11.8%
Source: CEC 2007 Net system Power Report		

3.8.4 Under Construction and Pre-Construction Resources

Under construction and pre-construction resources that have 2008 completion dates are considered by RETI to be part of the existing RPS-eligible renewable resources, but are not reported by the CEC 2007 Net System Power Report. A search for "under construction", "site preparation", and "permitted" projects was conducted using Ventyx's application Energy Velocity.

Renewable projects in the "permitted" stage have to meet the following criteria in order to be considered part of the existing RPS-eligible resources:

- A contract for energy sales
- All major siting and construction permits
- A transmission interconnection agreement

Table 3-22 shows the under construction and pre-construction projects that are considered RPS-eligible. Assumed capacity factors for each of the technologies are consistent with those reported in the Phase 1A report.

Table 3-22. RPS-Eligible Under Construction and Pre-Construction Resources

Stage	Resource	Project Capacity (MW)	Total Capacity (MW)	Total Energy Delivery (GWh)
Permitted	Solar	5	5	11
Site Preparation	Landfill Gas	4	4	27
Under Construction	Biomass Geothermal Landfill Gas Sludge Waste Solar Wind	2.2 66.0 19.4 1.4 0.3 300.5	390	1,224
Grand Total			399	1,262
Source: Black & Veatch query of Ventyx Energy Velocity database, July 28, 2008. Updated 13 October.				

The net short calculation does not consider planned and contracted new renewable generation which does not require new transmission facilities (for example, the 50 MW Klickitat wind project in Washington). While relatively modest currently, the omission of these resource may result in the net short being overestimated.

3.8.5 ~~California Solar Initiative~~Go Solar California Program

The Go Solar California program has a goal of installing 3,000 MW of distributed PV generating capacity by 2016.[14] ~~The California Solar Initiative (CSI) has reported that it is on target to contribute 100 MW of installed solar capacity to the grid by the end of 2008. The CSI program has a goal of installing 3,000 MW of solar generating capacity from the CPUC contribution of the general market program by 2016.~~[15] At the end of this period, it is hoped that the price of PV installations will have decreased and that installations will continue to increase without further public support. RETI assumes that the Go Solar California program will accomplish its goals and that growth will continue at the same rate through 2020 reaching a total of 4,100 MW. Many of the expected installations will be for self-generation and therefore will not contribute to the RPS, as described above. For purposes of estimating the renewable net short, RETI assumes that 50% of the electric energy from distributed PV installed will count toward the RPS. In addition, the average capacity factor for these installations is assumed to be 20%[16] Table 3-23 provides a breakdown of the expected ~~yearly~~ contribution of ~~CSI~~ Go Solar California capacity to the California RPS requirement, with straight line interpolation between the ~~2008~~ zero in 2006 contribution and the 2016 target and further extrapolated to 2020. ~~In estimating the total amount of CSI renewable energy credits (RECs) that will contribute toward the RPS, the following assumptions were made:~~

- ~~The capacity factor for solar technologies is assumed to be 25 percent.~~
- ~~50 percent of the energy and capacity would be credited toward the RPS~~

Formatted: Body Text

[14] The best-known component of the Go Solar program is the California Solar Initiative. California Public Utilities Commission, "California Solar Initiative, CPUC Staff Progress Report", July 2008.
~~[15] California Public Utilities Commission, "California Solar Initiative, CPUC Staff Progress Report", July 2008.~~
[16] "CPUC Self-Generation Incentive Program, Solar PV Costs and Incentive Factors, Final Report, February 2007, Figure 3-5.

Table 3-23. ~~CSI~~ Go Solar California Expected Contribution to RPS

Year	Total Installed Capacity (MW)	RPS Qualified Capacity (MW)	Total Energy (GWh)	RPS Qualified Energy (GWh)
2013	2,100	1,050	3,679	1,840
2016	3,000	1,500	5,256	2,628
2020	4,200	2,100	7,358	3,679

3.8.6 Contribution of Other Renewables

Several renewable energy technologies are not considered for in-depth analysis in this report based on several factors including the likely ability of the resource to contribute to California RPS requirements due to total resource potential, need for large-scale transmission, ability to cost-effectively deliver the resource to the California grid, and technology maturity. These technologies are expected to have some contribution to the RPS but are not sufficient resources to merit exploring potential new transmission access.

The RETI Phase 1A report estimated the resource potential for each of the following technologies: anaerobic digestion, landfill gas, small hydropower, wave and marine current. For the anaerobic digestion, landfill gas, and hydro projects, it was assumed that 50 percent of the California potential identified in the RETI Phase 1A report would be developed by 2020 and is included in the contribution assessment. For wave and marine current projects, Phase 1A identified a likely development path for each of these technologies through 2020. Due to the technical immaturity for capturing the potential of these resources, the amount of California potential expected to be utilized by 2020 is much lower: 8 percent for marine current and 5 percent for wave.

Table 3-24 shows a breakdown of the expected yearly energy delivery contributions of these renewable energy technologies. Only the contributions of projects within the state of California were considered in this section.

Table 3-24. Production Timescale and Energy Delivery for Other Renewables

Year	Anaerobic Digestion	Landfill Gas	Small Hydro.	Marine Current	Wave	Total Energy Delivery
	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)
2008	0	0	0	0	0	0
2009	86	41	29	0	0	155
2010	171	82	58	0	0	311
2011	257	123	87	0	0	466
2012	342	164	116	0	0	622
2013	428	205	145	0	0	777
2014	513	246	174	2	0	934
2015	599	287	203	3	93	1,184
2016	684	328	232	5	325	1,574
2017	770	369	261	9	556	1,965
2018	855	410	290	13	788	2,356
2019	941	451	319	17	1,020	2,748
2020	1,027	487	348	21	1,252	3,134

3.8.7 RETI Net Short

The RETI net short is the generation target to be met with resources identified in this project. The net short takes into account RPS demand as well as the base case resources and other renewables described above. The general equation for the RETI net short is:

RETI Net Short (GWh) =
{(California Energy ~~Demand~~Delivered by LSEs) x (Annual % RPS Requirement)}
- {(Operating Resources) + (Under Construction and Pre-Construction Resources)
+ (~~CSI~~ Go Solar California Contribution) + (Other Renewables Contribution)}

The contributions of operating resources, under construction and pre-construction resources, CSI, and the other renewables to the calculation of net short are given in Table 3-25~~Table 3-25~~. The incremental RETI net short is the difference between the current and next year's net short amount; the amount of renewable capacity that the state needs to construct in order to stay on course to meet the 33 percent ~~renewable~~ RPS goal by 2020, assuming that the contributions by the ~~CSI~~ Go Solar California program and other renewables are realized.

The ~~calculated~~ revised 2020 RETI net short ~~by 2020~~ is about ~~67,536~~56,000 GWh/yr. This revised value is approximately 11,500 GWh less than estimated in the

December, 2007, version of the RETI Phase 1B report. This reduction is due primarily to the use of LSE retail sales subject to the RPS instead of total consumption including self-generation. Secondarily, the revised estimate assumes that the goals of the Go Solar California program will be met and growth in solar installations will continue through 2020. ~~This~~ The revised RETI net short is equivalent to about ~~19,300~~16,000 MW at a 40 percent average capacity factor.

Figure 3-6~~Figure 3-6~~ is a graphical representation of the data presented in Table 3-25~~Table 3-25~~.

Table 3-25. RETI Net Short Calculations

	RETI Net Short	Incr. RETI Net Short	LSE Sales	Annual RPS Req.	Operating Resources	Under & Pre-Cons. Resources	RPS Qualif. PV	Other Renew-ables
Year	GWh	GWh	GWh	%	GWh	GWh	GWh	GWh
2010	5,485	2,194	271,146	16.1%	35,545	1,262	1051	311
2011	9,208	3,723	274,685	17.4%	35,545	1,262	1,314	466
2012	13,004	3,796	278,129	18.7%	35,545	1,262	1,577	622
2013	16,846	3,841	281,346	20.0%	35,545	1,262	1,840	777
2014	22,329	5,483	284,448	21.9%	35,545	1,262	2,102	934
2015	27,827	5,498	287,518	23.7%	35,545	1,262	2,365	1,184
2016	33,274	5,448	290,494	25.6%	35,545	1,262	2,628	1,574
2017	38,790	5,516	293,318	27.4%	35,545	1,262	2,891	1,965
2018	44,412	5,622	296,148	29.3%	35,545	1,262	3,154	2,356
2019	50,158	5,745	299,038	31.1%	35,545	1,262	3,416	2,748
2020	56,031	5,873	301,973	33.0%	35,545	1,262	3,679	3,134

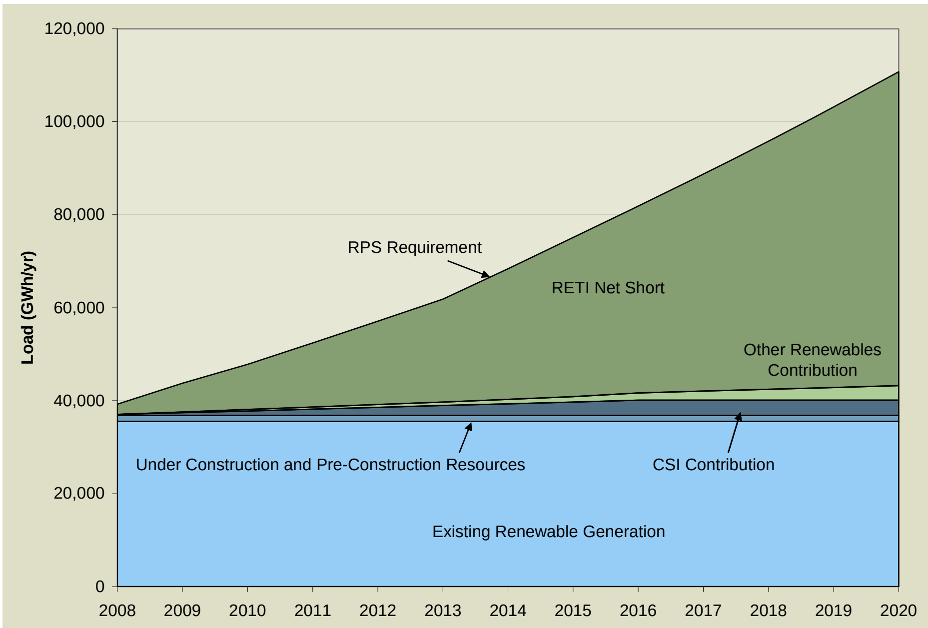


Figure 3-6. RETI Net Short Calculation

4.0