Public Interest Energy Research (PIER) Program
FINAL PROJECT REPORT

Renewable Resource/Transmission Development Scenarios

Prepared for: California Energy Commission
Prepared by: Center for Energy Efficiency and Renewable Technologies

DECEMBER 2011
CEC-500-2011-050

Prepared by:

Primary Author(s):
Rich Ferguson, Ph.D.
David Olsen

Center for Energy Efficiency and Renewable Technologies
Sacramento, California 95814

Contract Number: 500-06-048

Prepared for:

California Energy Commission

Clare Laufenberg Gallardo
Contract Manager

Linda Spiegel
Office Manager
Energy Generation Research Office

Laurie ten Hope
Deputy Director
RESEARCH AND DEVELOPMENT DIVISION

Robert P. Oglesby
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

ACKNOWLEDGEMENTS

The authors would like to express their appreciation for the unfailing guidance and assistance of the Public Interest Energy Research Program contract manager, Clare Laufenberg Gallardo. This project demanded an enormous amount of flexibility to respond constructively to developments in many venues during this project. She gave unstintingly of her time to provide advice and information to the authors and to the Center for Energy Efficiency and Renewable Technologies staff. Ms. Gallardo's ability to manage the course corrections required along the way was essential to the project's success.

Please cite this report as follows:

Ferguson, Rich, David Olsen. 2011. *Renewable Resource/ Transmission Development Scenarios*. California Energy Commission, PIER Program. CEC-500-2011-050

PREFACE

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program conducts public interest research, development, and demonstration (RD&D) projects to benefit California.

The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy Innovations Small Grants
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

Renewable Resource/ Transmission Development Scenarios is the final report for the Center for Energy Efficiency and Renewable Technologies project #CEC-500-06-048 conducted by California's Renewable Energy Transmission Initiative (RETI). The information from this project contributes to PIER's Renewable Energy Technologies Program.

For more information about the PIER Program, please visit the Energy Commission's website at www.energy.ca.gov/research/ or contact the Energy Commission at 916-327-1551.

TABLE OF CONTENTS

Preface ii

Abstract and Keywords v

Executive Summary 1

1.0 Introduction 4

1.1. Contract Goals 5
1.1.1. Tasks 5
1.1.2. Building Public Support for Renewable Transmission 8

1.2. RETI Background and Format 8

1.3. Contract Tasks Merged into RETI Process 9
1.3.1. RETI Coordination Activities 9

2.0 Project Approach 12

2.1. CREZ Identification and Characterization 12
2.1.1. Need for Remote Renewable Resources 12
2.1.2. Economic Assessment 13
2.1.3. Environmental Assessment 16

2.2. Conceptual Transmission Planning 18
2.2.1. Energy Access Assessment 18
2.2.2. Environmental Assessment 24

3.0 Project Outcomes 27

3.1. Phase 1 Report Overview 27

3.2. Phase 2 Report Overview 28

4.0 Conclusions and Recommendations 30

4.1. Benefits to California 31

5.0 References 32

6.0 Glossary of Terms 33

7.0 Bibliography 35

LIST OF FIGURES

Figure 1-1. Foundation Lines, Delivery Lines and Renewable Collector Lines. 23

Figure 1-2. Economic and Environmental Assessment of California CREZs. 27

LIST OF TABLES

Table 1-1. Economic Ranking of California CREZs. 15

Table 1-2. Transmission Groups Sorted by Energy, Environmental Rating and Cost. 22

Table 1-3. Environmental Ranking of California CREZs. 26

ABSTRACT

California's Renewable Energy Transmission Initiative has compiled an initial set of potential transmission facilities capable of accessing and delivering renewable energy sufficient to meet state 2020 renewable energy and greenhouse gas reduction goals. Also, the value of the energy delivered can quickly repay the cost of the transmission investment, as well as provide other benefits to consumers such as increased reliability, decreased congestion, and greater system efficiency.

This preliminary conceptual transmission plan is contained in the Renewable Energy Transmission Initiative *Phase 2A Final Report*, which was posted on September 23, 2009. Comprehensive information about the Renewable Energy Transmission Initiative, including its mission statement, participants and a record of its work is available at: www.energy.ca.gov/reti.

The purpose of the Renewable Energy Transmission Initiative initial conceptual transmission plan is to recommend priority transmission projects for detailed study by the California Independent System Operator and publicly owned utilities. Transmission facility components of this conceptual plan were identified and evaluated by the Renewable Energy Transmission Initiative Conceptual Planning Work Group, Competitive Renewable Energy Zone Revision Work Group and Environmental Work Group on the basis of system electrical needs and overall developmental capacity. It also considered economic and environmental costs.

This report summarizes the conceptual transmission plan. It describes how it was developed by a diverse group of stakeholders who have given generously of their time and expertise.

Keywords: Electric transmission, transmission planning, renewable energy, wind power, solar power, biomass power, geothermal power, AB 32, Competitive Renewable Energy Zone, CREZ, Renewable Energy Transmission Initiative, RETI

EXECUTIVE SUMMARY

Introduction

California has adopted energy policies that require substantial increases in electricity generation from renewable energy resources to supply 33 percent of the state's total electric needs. Implementation of these policies will require extensive improvements to California's electric transmission infrastructure.

Depending on the level of coal-fired electric imports, reducing electric sector greenhouse gas emissions to 1990 levels will require renewable energy sources (renewables) to supply 33 percent of the state's total electric needs. A least-cost, best-fit plan for adding renewables will likely require development of combinations of resources in different state regions including the Tehachapi and Imperial Valleys. Project and manufacturing economies of scale, land use and permitting constraints, and transmission access are key limitations on renewable resource development. New transmission is a prerequisite for this development. Given long transmission construction lead times, early identification of priority development zones and the transmission corridors to access them is essential.

The California Renewable Energy Transmission Initiative is a statewide initiative to help identify the transmission projects needed to accommodate these renewable energy goals.

Purpose

The primary purpose of this project was to identify potential renewable energy transmission projects. The Renewable Energy Transmission Initiative would develop possible transmission solutions to access up to four Competitive Renewable Energy Zones that have the best cost/benefit ratios and development-schedule rankings.

Project Objectives

The research project objectives are to:

- Provide the California Energy Commission with information needed to guide renewable energy and transmission development sufficient to meet Assembly Bill 32 (Nuñez, Chapter 488, Statutes of 2006) and Renewables Portfolio Standard goals.
- Estimate the costs and benefits of developing varying amounts of wind, geothermal, concentrating solar power, and organic waste resources, including transmission access and system integration costs, in regions across the state and in neighboring states.
- Identify candidate Competitive Renewable Energy Zones that may justify proactive development of transmission.
- Support and, as necessary, lead development of service plans for transmission needed to achieve state Renewables Portfolio Standard and emissions reductions goals.

Project Outcomes

The California Renewable Energy Transmission Initiative's work was organized in three phases:

- Phase 1: Identify and rank Competitive Renewable Energy Zones to create a statewide renewable resource assessment and short list of top-priority Competitive Renewable Energy Zones.
- Phase 2: Refine the Competitive Renewable Energy Zones analysis for priority zones and compile an initial set of conceptual renewable energy transmission solutions.
- Phase 3: Develop transmission plans of service for identified Competitive Renewable Energy Zones and initiate the permitting process for high-priority, near-term transmission projects.

The Phase 1 report is a high-level screening analysis that groups Competitive Renewable Energy Zones based on geographical proximity, development time frame, shared transmission constraints, and additive economic benefits. Competitive Renewable Energy Zones were ranked according to cost-effectiveness, environmental concerns, development and schedule certainty, and other factors to provide a renewable resource base for California. The Phase 1 report was completed and posted to the Renewable Energy Transmission Initiative's website on January 5, 2009.

The Phase 2 work focused on two major tasks:

- Expand evaluation and rerank the Competitive Renewable Energy Zones preliminarily described in Phase 1.
- Develop a statewide conceptual transmission expansion plan to access the Competitive Renewable Energy Zones.

The Phase 2 report presented the results of these activities and the processes used to obtain them. The Phase 2 report was completed and posted to the Renewable Energy Transmission Initiative's website on September 23, 2009.

Conclusions and Recommendations

The Renewable Energy Transmission Initiative Stakeholders Steering Committee recommends that:

1. The California Independent System Operator and publicly owned utilities study Renewable Foundation lines and Renewable Delivery lines as soon as possible to determine which are needed, and when they should be placed in service to meet state goals by 2020.
2. To avoid duplicative or redundant facilities, California planning authorities work closely with one another to identify, propose, study, and approve joint independently owned utility – publicly owned utility projects, and eliminate barriers to joint use of such facilities.

3. Multiple transmission charges be eliminated for purposes of all transmission line segments built primarily to access and deliver renewable energy in California, so that all transmission customers buying renewable energy sourced from California Competitive Renewable Energy Zones pay only one transmission charge.

4. The Energy Commission should begin immediately to designate additional appropriate corridors, beyond those already established by federal agencies or utilities' rights-of-way, to reserve and protect transmission access to areas where renewable energy development is likely to occur, including likely routes for Renewable Foundation lines and Renewable Delivery lines.

Benefits to California

Meeting California's renewable energy goals will require a substantial expansion of the state's electric transmission infrastructure. The crucial point for policy makers and the public is that transmission development leverages much larger investments in new generating resources. Transmission typically accounts for only a small percentage of the cost of the generation built to deliver energy over those lines. And the value of the energy delivered can repay the cost of the transmission investment quickly. In addition, transmission lines approved for the primary purpose of delivering renewable generation to the grid will provide other benefits to consumers such as increased reliability, decreased congestion, and greater system efficiency.

Note: All tables, figures, and photos in this report were produced by the authors, unless otherwise noted.

1.0 Introduction

California has adopted energy policies that require substantial increases in the generation of electricity from renewable energy resources. Implementation of these policies will require extensive improvements to California's electric transmission infrastructure.

The California Renewable Energy Transmission Initiative (RETI) is a statewide initiative to:

- Help identify the transmission projects needed to accommodate these renewable energy goals.
- Facilitate transmission corridor designation.
- Facilitate transmission and generation siting and permitting.
- Support future energy policy.

RETI is a joint effort among the California Public Utilities Commission (CPUC), the California Energy Commission (Energy Commission), the California Independent System Operator (California ISO), Investor-Owned Utilities (IOUs), public utilities and other stakeholders.

Depending on the level of coal-fired electric imports, reducing electric sector greenhouse gas (GHG) emissions to 1990 levels will require renewable energy sources (renewables) to supply 33 percent of the state's total electric needs. A least-cost, best-fit plan for adding renewables will likely require development of combinations of resources in different regions of the state, including the Tehachapi and Imperial Valleys. Project and manufacturing economies of scale, land use and permitting constraints and transmission access are key constraints on renewable resource development. New transmission is a prerequisite for this development. Given long transmission construction lead times, the early identification of priority development zones and the transmission corridors to access them is essential.

RETI's work is organized in three phases:

- Phase 1: Identify and rank Competitive Renewable Energy Zones (CREZs) to create a statewide renewable resource assessment and short-list of top-priority CREZs. (Completed)
- Phase 2: Refine the CREZ analysis for priority zones and compile an initial set of conceptual renewable energy transmission solutions. (This report completes Phase 2.)
- Phase 3: Develop transmission plans of service for identified CREZs and initiate the permitting process for high priority, near-term transmission projects.

The Energy Commission participated in the process that initiated RETI with the goals of the Contract and its scope of work, including development of potential transmission solutions for accessing priority CREZs in mind. Because of RETI's similarities to and overlaps with intended RETI outcomes, the Energy Commission converged the Public Interest Energy Research (PIER) contract work with RETI activities. Work toward the goals and objectives of this contract continued on this basis through September 2009, when the RETI *Phase 2A Final Report*, which includes an initial statewide conceptual transmission plan, was adopted by the RETI Stakeholder Steering Committee (SSC). This report summarizes the work completed through

the production of the *Phase 2A Final Report*. Subsequently, the Contractor's work has been supported by a work authorization under a different contract.

1.1. Contract Goals

The goals of the research agreement are to:

- Provide the Energy Commission with information needed to guide renewable energy and transmission development sufficient to meet Assembly Bill 32 (Nuñez, Statutes of 2006, Chapter 488) and Renewables Portfolio Standard (RPS) goals.
- Estimate the costs and benefits of developing varying amounts of wind, geothermal, Concentrating Solar Power (CSP) and organic waste resources, including transmission access and system integration costs, in regions across the state and in neighboring states.
- Identify candidate Renewable Resource Zones (RRZs) that may justify proactive development of transmission.
- Support and, as necessary, lead development of consensus plans of service for transmission needed to achieve state RPS and emissions reductions goals.

1.1.1. Tasks

The tasks required to complete the project were clearly defined in the scope of work document and focus on a thorough research, review, and reporting system.[1]

Contract Task 1: Administer the contract

The goal of Task 1 is to establish the lines of communication and procedures for implementing this agreement. Task details included a kick-off meeting, list of participants, a schedule of deliverables, critical project review (CPR) reports, monthly progress reports, a final meeting to close out the agreement, and this final report.

The Monthly Progress Reports summarized all agreement activities conducted by the contractor for the reporting period, including an assessment of the ability to complete the agreement within the current budget and any anticipated cost overruns.

Task 1 also included identifying and obtaining matching funds and documenting that no permits are required for the project.

Contract Task 2: Construct Resource/Technology Development Scenarios

Task 2 provided detailed scenarios of different CSP development projects, constructed to identify the total costs of developing different size projects in different locations, including transmission costs. The scenarios include potential renewable energy produced by wind, solar, geothermal, and biomass generators throughout the existing CREZs.

The goals of Task 2 are to:

[1] Document 506048, Exhibit A – SOW 04-27-07

- Estimate the delivered cost of energy for CSP for projects of various sizes, inclusive of transmission access, siting, and permitting costs.
- Estimate the delivered cost of energy for geothermal projects of various sizes, inclusive of transmission access, siting and permitting costs, for projects located in Inyo County/western Nevada; Northern California; and Imperial County.
- Identify the likelihood that the use of dairy waste and other forms of biomass can be expanded to contribute significantly to meeting AB 32 goals.
- If so, develop one or more development scenarios, depending on resource availability.
- Estimate the delivered cost of energy for wind projects of various sizes, inclusive of transmission access, siting, and permitting costs, for 2,000 MW of additional generation at Tehachapi; for projects located in San Bernardino, Riverside, and Imperial Counties; in western Nevada; and in Northern California.
- Identify the transmission requirements of each type of development scenario.
- Provide a development schedule for each type of scenario.
- Identify a least-cost portfolio of renewables able to meet RPS and AB 32 goals by calculating and comparing the total cost of meeting AB 32 GHG reduction targets with various combinations of such resources.

The deliverables of Task 2 are:

- CSP Scenarios Report
- CSP Meeting Presentations (No Draft / Final)
- Record of Meeting Attendance (CSP) (No Draft / Final)
- Geothermal Development Scenarios Report
- Geothermal Meeting Presentations (No Draft / Final)
- Record of Meeting Attendance (Geothermal) (No Draft / Final)
- Biomass Development Scenarios Report
- Biomass Meeting Presentations (No Draft / Final)
- Record of Meeting Attendance (Biomass) (No Draft / Final)
- Wind Development Scenarios Report
- Wind Meeting Presentations (No Draft / Final)
- Record of Meeting Attendance (Wind) (No Draft / Final)
- Renewable Development Portfolio Report
- 1st CPR Report

Contract Task 3: Identify Renewable Resource Zones (RRZs) That May Justify Proactive Transmission Development

The development evaluated in Task 2 may be most cost-effectively organized by grouping it into resource and transmission zones. Task 3 will involve stakeholders to identify candidate

RRZ, based in part on the cost, schedule and transmission information compiled in evaluating Task 2 scenarios. The RETI SSC chose to use the term Competitive Renewable Energy Zones (CREZs) rather than Renewable Resource Zones. RETI CREZs are equivalent to the RRZs described in this contract. From this point forward, this report will use the term CREZ rather than RRZ in the text relating to RETI. At least some potential CREZs are likely to include combinations of different renewable resources rather than being dedicated to only one resource. CREZs may also extend into adjoining states. This task will also investigate transmission development synergies between potential CREZs.

The goals of Task 3 are to:

- Identify criteria for designating CREZs, based on stakeholder input.[2]
- Identify potential CREZ, based on stakeholder input, transmission synergies between resource areas and Task 2 data.
- Estimate the costs and benefits of combined generation/transmission development in potential CREZ.
- Rank candidate CREZ according to their costs and benefits and the CREZ-designation criteria identified elsewhere in this task.

The deliverables of Task 3 are:

- CREZ Meeting Presentations (No Draft / Final)
- Record of Meeting Attendance (CREZ) (No Draft / Final)
- CREZ Potential Meeting Report(s)
- CREZ Criteria Report
- List of Potential CREZ (No Draft / Final)
- Potential CREZ Ranking Report
- 2nd CPR Report

Contract Task 4: Develop Transmission Solutions for Priority CREZ

The contractor will work with the California ISO and stakeholders to develop conceptual transmission solutions to access up to four of the CREZs having the best cost/benefit ratios and development-schedule rankings. Plans for each CREZ will recommend transfer capacity, phasing, potential corridor routing, and conceptual cost estimates.

The goals of Task 4 are to:

- Identify potential transmission corridors capable of providing access to priority CREZs.
- Develop conceptual plans of service for all transmission facilities necessary to access as many as four priority CREZs.

[2] RETI, being a volunteer collaborative effort, does not have the authority to formally designate CREZs. Therefore, RETI's efforts relied on identifying CREZs.

The deliverables of Task 4 are:

- First CREZ Conceptual Transmission Plan
- Second CREZ Conceptual Transmission Plan (If Approved)
- Third CREZ Conceptual Transmission Plan (If Approved)
- Fourth CREZ Conceptual Transmission Plan (If Approved)

1.1.2. Building Public Support for Renewable Transmission

New transmission lines are understandably controversial, especially those that require new rights of way. The California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) require that the public be given the opportunity to comment on proposed transmission lines and alternatives to them. Early and active involvement by interested parties in the selection and assessment of alternate routes prior to the formal approval process increases the possibility of public support for the final selection, even though it is perhaps impossible to avoid all opposition to new lines.

RETI actively involved stakeholders in conceptualizing how large amounts of renewable energy can best be delivered to customers, in order to ensure that transmission expansion plans fully consider the interests of all those constituencies who may be affected by, and whose support will be needed to support the approval of new infrastructure.

The RETI Stakeholder Steering Committee (SSC) formed a Conceptual Planning Working Group (CPWG) to develop a statewide conceptual transmission expansion plan. The CPWG members included representatives of all major transmission providers, Load-Serving Entities (LSEs), regulatory and permitting agencies, renewable energy generators, environmental organizations, and other stakeholders. The CPWG met bi-weekly beginning in October 2008; from January 2009 on, it then met weekly, in person and via web conference.

RETI also conducted public review meetings to inform and solicit feedback. The purpose of these meetings was to provide information during the public review phase on the potential project development in impacted areas. The meeting format included an overview presentation, small breakout discussion sessions; and concluded with a public comment session. RETI publicized these meetings as Plenary Stakeholder Group (PSG) meetings and held them in Palm Desert (January 10, 2009); Victorville (June 18, 2009); Redding (June 23, 2009); and Sacramento at the Sacramento Municipal Utility District (SMUD) headquarters (June 24, 2009).

1.2. RETI Background and Format

RETI is a stakeholder-driven planning process initiated by the CPUC, Energy Commission, California ISO, and publicly owned utilities (POUs). Its goal is to identify and build the basis for approving the next major transmission facilities necessary to access a quantity of renewable generation sufficient to meet statewide climate change and renewable energy goals. The RETI Stakeholder Steering Committee (SSC) includes representatives of all key interests concerned with the transmission access necessary to support renewables development in the state: all transmission owners and providers; Load-Serving Entities; wind, solar, geothermal and

biomass generators; federal and state permitting agencies; the military; and consumer, environmental and local (county) interests.

Conceptual planning is normally done by experts who have detailed knowledge of the operational characteristics of individual transmission systems. These experts use their judgment to identify potential upgrades or new facilities for detailed study. Because it relies on expert knowledge and is judgment-based, this process is rarely transparent, and it has been difficult to incorporate stakeholder perspectives at the conceptual planning stage in ways that build broad support for transmission expansion. Incorporating a wide variety of committees and stakeholders throughout the entire project increases community involvement and support.

The core RETI committee is the Stakeholder Steering Committee. The SSC is the comprehensive group of stakeholders involved in identifying and ranking CREZs. The SSC also convened working groups to resolve technical and policy-related issues, and to involve a broader range of stakeholder interests concerned about particular aspects of generation-transmission development.

In addition to participating in Working Group meetings, members of geothermal, solar and wind companies held industry-specific regular conference calls and e-mail exchanges about on-going CREZ identification and ranking work. Environmental stakeholders also held conference calls and e-mail exchanges on CREZ identification and ranking, through EWG meetings and outside of such meetings. The Contractor coordinated most of these meetings.

1.3. Contract Tasks Merged into RETI Process

RETI is a statewide initiative to help identify the transmission projects needed to accommodate California's renewable energy goals, support future energy policy, and facilitate transmission corridor designation and transmission and generation siting and permitting. RETI has been and will continue to be an open and transparent collaborative process in which all interested parties are encouraged to participate.

PIER contract #500-06-048 with the Center for Energy Efficiency and Renewable Technologies allowed for the development of renewable energy and transmission guidelines to meet AB 32 and RPS goals.

The Energy Commission converged the PIER contract #500-06-048 work into RETI activities designed to identify potential renewable energy transmission projects.

The Contractor played a leading role in recruiting stakeholders representing the broad spectrum of interests and perspectives to participate in the RETI process, and in organizing and coordinating the many stakeholder meetings outlined in this report.

1.3.1. RETI Coordination Activities

The SSC convened working groups that often met weekly, initially by conference call and later by internet conferencing.

In addition to participating in the working group meetings described below, members of geothermal, solar and wind companies held industry-specific regular conference calls and

electronic mail exchanges about on-going CREZ identification and ranking work. Environmental stakeholders also held conference calls and e-mail exchanges on CREZ identification and ranking, through Environmental Work Group (EWG) meetings and outside of such meetings.

Meetings of the RETI Phase 1A Work Group

In contract Task 3, the Contractor formed a Phase 1A Work Group (also referred to as the Assumptions and Methodology Work Group) to provide stakeholder input on RETI assumptions and methodology, and specifically on wind resource potential estimates, and wind technology costs and operating parameters. RETI SSC members serving on this work group included representatives of the wind industry, Regional Council of Rural Counties (RCRC), SDG&E, SCE, SMUD, the CPUC and the Energy Commission. Requests for data and for review of proposed methodology were sent by SSC representatives of the wind, biomass, solar and wind industries to all companies in those technologies active in project development in the state.

The Phase 1A Work Group was formed at the January 22, 2008 SSC meeting. It met weekly by webcast/conference call beginning January 29, 2008 through March 6, 2008 to resolve questions about resource and technology assumptions involved in producing the RETI Phase 1A report. The Contractor convened and coordinated each of these meetings.

Meetings of the RETI Phase 1B Work Group

The Contractor formed a Phase 1B Work Group to provide stakeholder input and guidance in the identification of renewables generating projects, and the identification and ranking of CREZ. SSC members of this work group included representatives of the wind, biomass, solar and wind industries; PG&E, Southern California Edison, SMUD, and Los Angeles Department of Water and Power; the Sierra Club and NRDC; the CPUC; and the Energy Commission.

Specific issues referred to the work group included development of criteria for application of the Phase 1A methodology for dealing with the uncertainty of some economic input assumptions; for determining the MW quantity of renewable generation to be brought into Phase 2 conceptual transmission planning; and for definition of reference and alternative modeling cases and selection of related energy price forecasts.

The Phase 1B Work Group was formed at the May 21, 2008 SSC meeting. It met by webcast/conference call on these dates in 2008: May 27; June 5; June 12; June 26; July 3; and July 24. The Contractor convened and coordinated each of these meetings.

Environmental Work Group Meetings

Because all parties have an interest in minimizing the environmental costs of generation-transmission development, environmental considerations are at the center of CREZ identification. The RETI Stakeholder Steering Committee proposed formation of an EWG at its March 19, 2008 meeting in order to bring a broad spectrum of environmental perspective into the work of identifying and ranking zones. The work of the EWG, and in particular the process it developed for ranking candidate zones by level of environmental concern is described in

Section III of the RETI *Phase 1B Final Report* (December 2008), "Environmental Assessment of Competitive Renewable Energy Zones."
The EWG held its first meeting on April 16, 2008, following the SSC meeting that day. The EWG then met every Thursday at 10:30 AM through the remaining eight months of 2008 with only a few exceptions. As the RETI Phase 1B report neared completion, the EWG often met several times a week. Meetings were initially by conference call, and beginning in July 2008, by webcast.

The Contractor coordinated all of these meetings and calls, and led development of the quantitative methodology adopted by the EWG to provide an objective basis for comparing parameters of environmental concern. This environmental evaluation was essential to the RETI process, as CREZ identification considered both economic and environmental rankings.

Participation on the EWG has been, and continues to be, open to all. The EWG strives to make decisions by the consensus of all participants, and in practice, almost all EWG positions have been agreed to by the large and diverse group. In cases where consensus was not possible to achieve, voting was restricted to the RETI SSC members of the EWG.

Participants in EWG meetings included federal, state and local permitting agencies; environmental Non-Governmental Organizations (NGOs); utility company and renewable energy developer land and permitting staffs; and interested citizens.

2.0 Project Approach

2.1. CREZ Identification and Characterization

RETI has completed its preliminary assessment of Competitive Renewable Energy Zones that can provide renewable energy for California. The economic and environmental CREZ ranking methodologies have also been previously reported.[3]

The CREZ ranking process has been guided by a diverse group of stakeholders who have given generously of their time and expertise. This analysis is believed to be the most comprehensive ever undertaken, and the results will provide a robust basis for planning transmission connections to major renewable resource areas.

2.1.1. Need for Remote Renewable Resources

RETI assessed all CREZs in California and in neighboring states that can provide significant electricity to California consumers by the year 2020. RETI also identified zones that can be developed in the most cost effective and environmentally benign manner. Many of the areas are in remote areas. This report discusses which resource areas across the state and which combinations of renewable resources within them can best justify development and can most quickly pay back the cost of building the transmission to access them.

Net Short Calculation and Revision

The RETI renewable energy target is the amount of additional renewable energy needed to provide 33 percent of California's electric energy consumption in the year 2020. The amount of new renewable energy requiring transmission is referred to as the RETI *net short* and was estimated to be about 68,000 GWh/yr.[4] For purposes of identifying preferred California CREZs capable of supplying an adequate quantity of renewable energy for planning purposes, allowance has been made for uncertainties in the assessment, for the desirability of ensuring competition between developers of various technologies, and for the likelihood that some

---

[3] Previous RETI documents and other materials can be found on the RETI web site at [http://www.energy.ca.gov/reti/index.html].

Economic assumptions and assessment methodology are described in, "Renewable Energy Transmission Initiative Phase 1A Final Report," May 17, 2008; environmental assessment methodology is described in, "Interim Draft Phase 1B Report, August 15, 2008." Both reports are available at: www.energy.ca.gov/reti/documents/index.html.

[4] It is important to note that the Net Short accounts for existing and under-construction resources, contributions from the California Solar Initiative, and the generation from smaller renewable resources not assessed in RETI Phase 1B, such as landfill gas, hydro, and marine energy. For more information, refer to the volume "Economic Assessment of Competitive Renewable Energy Zones." The RETI Net Short discussed in the text above was based on the Energy Commission's *2007 Integrated Policy Report* available at: [http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF].

renewable energy will be imported from out of state. California CREZs with the best economic scores sufficient to supply about 100,000 GWh per year are shown in Table 1-1.

The conceptual plan described in this report is a work in progress. It identifies conceptual connections capable of delivering much more renewable energy than the RETI planning target of 160 percent of the estimated renewable net short. In the future RETI will need to prioritize and narrow down the number of line segments. The current plan includes line segments likely to be redundant, so some will be reconsidered; others may be added. CREZ data continues to be updated as more information becomes available on out of state resources, land use managers amend their plans, and renewable development patterns change. Assessment results will continue to be updated so that mid-course corrections can be made in the future.

Despite the limitations inherent in CREZ and transmission element data and assessment methodology, the current plan provides a stakeholder-vetted basis for detailed planning by the California ISO and POUs. This detailed planning includes the contingency-based power flow modeling and economic grid simulations necessary to confirm the need for and cost-effectiveness of projects in the RETI conceptual transmission plan.

2.1.2. Economic Assessment

The economic ranking of renewable energy resources focused on California, with less detailed analysis of resources in Nevada, Arizona, the border region of Baja California, and the Pacific Northwest including British Columbia. It was performed by Black & Veatch with the assistance of the Phase 1B Working Group. Maps and other supporting materials are available on the RETI web site at: [http://www.energy.ca.gov/reti/documents/index.html].

The economic assessment estimates the cost of developing renewable resources throughout these areas and transmitting the energy to California consumers. In addition, the assessment estimates the value of this energy by considering the time of day and capacity value of the resource (its contribution to system reliability). The difference between the estimated cost and value provides the basis for ranking the CREZs.

CREZs were identified based on density of resources in different areas, estimated cost of developing them, and shared transmission constraints. Using these considerations, Black & Veatch identified approximate geographic boundaries of each CREZ in California, as well as general areas within each CREZ deemed suitable for biomass, geothermal, solar and wind energy development.

CREZ identification respected areas specified by RETI's Environmental Working Group as prohibiting or restricting energy development as a result of law and policies. Excluded areas are described in the chapter of this report entitled "Environmental Assessment of CREZs."

A CREZ may contain two types of projects: those known to be planned or proposed by renewable energy developers (referred to as "pre-identified" projects); and areas believed to be suitable for development but in which developers' interest is yet unknown (referred to as "proxy" projects).

An initial assessment identified resource areas sufficient to provide renewable energy far in excess of California's 2020 needs. At the direction of the Stakeholder Steering Committee, initial screening was performed to winnow the prospects to a more manageable number based on expected economic viability. As a result, 29 California CREZs capable of delivering total annual energy of approximately 200,000 gigawatt-hours per year (GWh/yr) were identified.[5] In addition, about 70,000 GWh/yr of smaller-scale resources not in CREZs were modeled in California. These included resources such as distribution-level solar photovoltaics and biomass projects which do not require large scale transmission upgrades. Finally, an additional 110,000 GWh/yr of resources were identified in other states, British Columbia and Baja California Norte. While there are significantly more resources potentially available out-of-state, these resource were modeled as the most economically competitive for imports.

CREZs are ranked on the basis of the *weighted average* cost and value of all the projects in each CREZ. High cost projects raise the average cost assigned to a CREZ. Lower cost projects are thereby disadvantaged by their geographic association with higher cost projects. To counter this effect, six of the California CREZs were divided into two "sub-CREZs" and one was divided into three sub-CREZs for a total of 37 distinct areas in California. Out-of-state resources areas were also sub-divided to convey the range of costs in these regions.

Table 1-1 provides the weighted average rank 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. 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 would be slightly different.[6] Rank costs presented in the remainder of this section include the transmission capital cost component unless otherwise indicated.

---

[5] CREZ maps are available at: [http://www.energy.ca.gov/reti/documents/index.html]. One gigawatt-hour equals 1,000 megawatt-hours (MWh). Total California electric demand in 2007 was approximately 240,000 GWh in 2007.

[6] 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. For more information, including impacts on supply curves, refer to the volume "Economic Assessment of Competitive Renewable Energy Zones."

Table 1-1. Economic Ranking of California CREZs.				
CREZ Name	**Annual Energy (GWh/yr)**	**Cumulative Energy (GWh/yr)**	**Weighted Average Rank Cost ($/MWh)***	
			Base Transmission Cost	**No Transmission Capital Cost**
Solano	2,721	2,721	-29	-29
Palm Springs	2,465	5,186	-20	-26
Victorville-A	2,112	7,298	-17	-21
Imperial North-A	10,095	17,393	-13	-13
Round Mountain-A	1,598	18,990	-11	-22
Fairmont	18,318	37,308	-9	-11
Tehachapi	25,091	62,400	-3	-9
Riverside East-A	2,339	64,739	3	3
Victorville-B	2,267	67,006	4	-2
Kramer	16,251	83,257	5	-3
Inyokern	7,136	90,393	8	-3
Owens Valley	3,433	93,826	10	-7
Twentynine Palms	1,944	95,769	15	3
San Bernardino - Lucerne	10,722	106,491	16	9

** The base transmission cost case (fourth column) includes all elements of the rank cost formulation as described in the economic assessment. The fifth column excludes the capital cost component of the transmission cost from the rank cost formula.

Economic assessment of CREZs depends on assumptions about generating technology costs and output characteristics, transmission costs, and the locational, seasonal and diurnal value of the electricity generated; and on assumptions about policy support and technology development. The SSC helped to develop, and agreed in general on the assumptions used, as described in the RETI *Phase 1A Final Report*. Despite this stakeholder agreement, many input assumptions remain inherently uncertain. Black & Veatch conducted an uncertainty analysis to illustrate the effects of different input cost assumptions. This analysis shows that different, but reasonable, assumptions about cost parameters may make some CREZ relatively more or less economically attractive. CREZ ranking as presented in CREZ economics were evaluated in greater detail in RETI Phase 2.

Black & Veatch also conducted sensitivity analyses to illustrate the effect of different policies (e.g., extension or revocation of tax credits for renewable technologies), and of different technology costs (e.g., more rapid than expected cost reduction in solar photovoltaic thin-film technologies). Tables summarizing CREZ rankings under different sensitivity scenarios are presented in the *Phase 1A Final Report*.[7]

[7] The sensitivity assessments include tax credits, energy value, capacity value, reduced solar costs, expanded geothermal potential, full allocation of transmission costs, and no transmission capital costs. Of these, the reduced solar cost sensitivity showed the most substantial variation from the base case. If substantial reductions in solar cost can be achieved, then both large scale solar resources and non-CREZ solar resources would benefit significantly. More information is provided in the Economic Assessment section.

Transmission costs calculated by Black & Veatch and used in the Phase 1 economic ranking assume simultaneous delivery of the full nameplate generating capacity of every CREZ. This conservative approach, appropriate for a high-level screening analysis, likely overstates the amount and cost of the transmission facilities necessary to meet current state GHG and renewable energy goals. As agreed by the SSC in its *Phase 1A Final Report*, Black & Veatch treated major transmission projects in Southern California approved by the California ISO or publicly owned utilities as already built. Some generating projects in CREZs near these facilities thus were not assessed for a portion (or all) of their transmission route. Black & Veatch performed a sensitivity analysis in this *Phase 1B Final Report* to investigate the effect an assumption of such "free" transmission had on CREZ ranking, and found little effect. Since the transmission costs for the economic assessment of CREZs assumed electricity delivery only to the nearest load center, comments on the *Phase 1B Draft Report* questioned the economic assessment ratings of the Southern California CREZs since they do not include the transmission upgrade costs to deliver this electricity reliably to Northern California load centers. A more detailed analysis of transmission costs addressing all of these issues was carried out in Phase 2, and the results used to re-rank CREZs as appropriate.

Results of the economic assessment and the environmental assessment described below are intended only to guide initial planning of the transmission facilities necessary to meet state renewable energy goals. The assessments are not intended to usurp local, state or federal project permitting authority, nor to impinge on the ability of renewable energy to be developed in other areas. Inclusion or omission of a resource area in a CREZ is not intended to prejudge the economic or environmental viability of any project. Any project, whether inside or outside a CREZ, may seek access to transmission capacity developed as a result of RETI or otherwise, consistent with market processes, transmission policy and permitting requirements.

2.1.3. Environmental Assessment

Environmental Work Group

At the direction of the SSC, the EWG assessed potential environmental concerns associated with CREZs identified by Black & Veatch and the renewable energy development areas within them. The EWG is chaired by the two environmental group representatives on the SSC and involved active participation by a large number of stakeholders.

The EWG identified areas in which energy development is prohibited or significantly restricted by law or policy. CREZs identified by Black & Veatch were designed to be consistent with these restrictions.

CREZ Revision – Phase 2

Initial CREZ outlines were roughly drawn to surround identified development areas and associated connecting power lines, but these initial outlines were deemed to be unduly arbitrary and unnecessarily large for assessment purposes. In response, Black & Veatch shrank the outlines to the minimum area required to encompass the development areas and associated connecting transmission lines, a process referred to as "shrink-wrapping" the CREZ boundaries. These smaller and more focused outlines were the CREZ boundaries used by the EWG in its

assessment. A two mile buffer zone was also identified for each CREZ, and the area of concern associated with transmission lines was extended one-half mile on both sides of the line.

Of the 37 California CREZs and sub-CREZs identified by Black & Veatch, only 30 of the most cost effective areas were assessed by the EWG due to technical reasons which could not be resolved in time for this report.

Issues Matrix

Environmental considerations and other issues that could potentially affect the ability to site and permit renewable energy generating projects were evaluated for each of the 29 California CREZ using environmental issues matrices. These can be found in online supporting materials, at: [http://www.energy.ca.gov/reti/documents].

Parcelization

Some of the private lands found to be extensively parcelized are close to existing infrastructure or have been disturbed, and thus appear to provide otherwise attractive locations for renewable energy development. With this in mind, several comments on the *Phase 2A Draft Report* assert that proxy projects should be sited even where there are more than 20 owners per two square mile areas.

The CREZ Revision Work Group (CRWG) chose the 20-owner criterion based on the experience of solar and wind project developers. As a practical matter, the work of finding and negotiating land lease or purchase agreements with so many owners lengthens development time and increases development cost to levels that make projects on such lands uneconomic.

At the same time, RETI stakeholders agree that utilizing disturbed private lands close to existing infrastructure for renewable energy development should be a priority for the state. County governments and state agencies are in the best position to develop mechanisms to consolidate the ownership of extensively-parcelized lands that have excellent renewable resource potential. For this reason, the RETI *Phase 2A Final Report* includes a formal recommendation that the Energy Commission, in conjunction with other state and federal agencies, counties and the renewable energy industry, develop and implement a strategy for consolidating ownership of disturbed or degraded private lands for renewable energy development on an expedited basis.

2.2. Conceptual Transmission Planning

The initial transmission expansion plan presented in this report represents the consensus recommendation of a diverse set of stakeholders on a set of major upgrades of the California grid, referred to here as Renewable Foundation lines and Renewable Delivery lines. These facilities increase the capacity of the grid, allowing energy to flow north or south as needed (Foundation lines), and deliver energy to load centers (Delivery lines). RETI does not have the capability to determine the extent to which the existing grid can accommodate new sources of renewable generation. However, these lines are likely to be required, given the amount of renewable energy required to meet state goals in 2020. Importantly, they are also are likely to be needed to meet growing energy demand regardless of generation source. Lines likely to be used no matter how the future unfolds—how population grows, energy efficiency savings accrue and generation develops—are referred to as least-regrets upgrades. They are so named because decision-makers who approve, and the customers who pay for, such infrastructure are unlikely to regret doing so. Identifying this set of least-regrets upgrades is a major outcome of RETI Phase 2 work.

In addition to Renewable Foundation lines and Renewable Delivery lines, the plan includes groups of Renewable Collector lines which provide access to geographically-adjacent CREZ. These groups, and the line segments of which they are comprised, are discussed in Chapter 3, and detailed in Appendices F and G of the *Phase 2A Final Report* available at: [http://www.energy.ca.gov/reti/documents/index.html].

This plan has been developed using a transparent and objective methodology for evaluating conceptual transmission connections that combines renewable energy access and environmental considerations. This methodology supports an unprecedented level of stakeholder involvement in conceptual planning geared specifically to evaluate transmission for renewable energy. It has the significant limitations explained in Chapter 3 of the *Phase 2A Final Report*. But at a time when national and regional transmission planning is increasingly being tied to renewable energy development, stakeholder involvement in planning will help build public acceptance of the required infrastructure. Development of this ranking methodology is a second significant outcome of Phase 2.

2.2.1. Energy Access Assessment

Conceptual Planning Work Group

The SSC formed a Conceptual Planning Working Group to develop a statewide conceptual transmission expansion plan. Work Group members include representatives of all major transmission providers, Load-Serving Entities (LSEs), regulatory and permitting agencies, renewable energy generators, environmental organizations, and other stakeholders. The Work Group met bi-weekly beginning in October 2008; from January 2009 on, it then met weekly, in person and via web conference.

The SSC specified major assumptions the Work Group was to use in developing this plan in a Phase 2 Guidance Document [http://www.energy.ca.gov/reti/steering/2008-12-17_meeting/2008-12-15_RETI_Phase_2_Guidance.PDF]. These directed that the plan should: 1) provide access for

approximately 100,000 GWh/year of renewable energy (160% of the target for new renewable energy in 2020); 2) include some level of access to all CREZ; and 3) provide for import of approximately 15,000 GWh/year of renewable energy from out of state resources. The SSC also directed the CPWG to assume that only 40% of the energy output potential of each CREZ would actually be developed by 2020.[8] To further limit the amount of new transmission facilities found necessary, CPWG planning also assumed that wind generation (much of which occurs during nights and evenings) and solar generation located in the same region could share the same transmission capacity.

Proposed Network Upgrades

Using its collective judgment, the CPWG first assembled a comprehensive list of potential network line segments having sufficient capacity to provide access to all CREZ and cost-effective out of state resource areas, and to allow delivery of renewable energy to all LSEs adequate to meet their policy goals. These conceptual connections between substations were mapped to understand their proximity to areas having known land use restrictions or other environmental sensitivities. Segments found to be in conflict with these restrictions were reconfigured or eliminated from consideration.

Many of the line segments proposed are already in various stages of planning by various transmission owners. This prompted considerable debate over whether facilities in advanced stages of planning should automatically be included in the conceptual plan without further assessment of their renewable energy attributes. In order to identify the most effective ways to access renewable energy on a consistent basis across all transmission owner systems statewide, the SSC decided that the RETI conceptual plan should evaluate the renewable energy attributes of all proposed transmission facilities which have not yet received permission to be constructed.

Shift Factor Analysis

This transmission system configuration, with the proposed new network facilities added, was analyzed for RETI by San Diego Gas & Electric Company using the ABB GridView computer program. The program injects a small amount of energy from each RETI CREZ, one at a time, and withdraws this energy at LSE load centers, in proportion to each LSE's net short estimates. The program calculates the fraction of these small energy injections which would flow in every segment of the WECC grid, including the proposed RETI line segments. These fractions are known as "power distribution factors" or "shift factors." They provide the basic information on the energy from each CREZ which flows in each line segment of the conceptual plan.

The shift factors were then combined with four different sets of energy information associated with each CREZ to provide a renewable energy rating for each line segment. The four rating criteria employed capture the economic and environmental score of each CREZ, as revised in

---

[8] On-going work indicates that less than 40% of the output of each CREZ may be required to meet the state's 33% RPS goal, and this conceptual planning target may be revised downward, to 35% or less.

Phase 2 planning assumes that 100% of the potential energy output of Tehachapi wind and Imperial Valley geothermal resources will be developed, along with 100% of the Out of State resource potential (Baja, Nevada, Oregon/Washington, British Columbia) found to be economic in Phase 1.

Phase 2; the energy output of each CREZ; and commercial interest, represented by the amount of energy able to be provided by projects having Power Purchase Agreements and/or queue positions in each CREZ.

Cost Estimates

The conceptual and very rough cost estimates presented in Table 1-1 were prepared using standardized cost factors, to enable comparison of segments on a consistent basis. Preparation of transmission cost estimates is discussed in Section 3.6 of the *Final Phase 2A Report*.

The 14 segments in the Foundation Group, four of which are double-circuit 500 kV facilities, were estimated to have an aggregate cost of $5.6 billion. Because the segments in this group provide major system benefits and are likely to be needed to meet load growth regardless of generation source, it is not appropriate to attribute their cost to the cost of meeting renewable energy or climate change goals. For the same reason, the aggregate cost of the 13 Delivery lines – $3.4 billion – should not be attributed solely or primarily to renewable energy development.

The groups of lines on Table 1-1 (above) provide transmission capacity well in excess of that required to meet the 33 percent renewable energy goal in 2020. Power flow and economic grid simulation studies to be performed by the California ISO and POUs will determine which lines are needed, and when they should be placed in service. Until such studies are completed, there is little basis for estimating the aggregate cost of the new transmission necessary to meet the 33 percent goal. Lines will not be approved unless they are found to be needed by permitting authorities.

Grouping Line Segments

The line segments were combined into functional groups, with line segment information combined to provide overall results for each group.

Environmental ratings and investment cost for each line segment were also compiled for each group, alongside group energy ratings. This information is summarized for comparison purposes on Table 1-2 below.

Explanation of Information on Table 1-2.

Group Combined CREZ Energy: The CREZ Energy column refers to the amount of renewable energy, in Gigawatt-hours (millions of kilowatt-hours), flowing on the lines in the group. Each of the 14 line segments in the Foundation line group carries renewable energy from several CREZ. As a group, when the flows on each of these lines are added together, they carry a very large amount of renewable energy. Because of this, Foundation lines and Delivery lines are not directly comparable to Collector lines, and have been shown separately on Table 1-1.

Collector lines, such as in the Carrizo group, carry renewable energy only from one or a few CREZ. It is important to note that, because the same renewable energy may flow on multiple line segments, the energy in this column does not represent the amount of such energy delivered to customers.

Group Environmental Rating: In this column, lower numbers represent less environmental concern.

Table 1-2. Transmission Groups Sorted by Energy, Environmental Rating and Cost.

Foundation & Delivery Lines			
	Group Combined CREZ Energy (GWh)	Group Enviro Score	Group Cost ($Million)
Foundation	52759	1119	$3,481
Delivery	12945	739	$1,075

Collector Lines					
Group	Group Combined CREZ Energy (GWh)	Group	Group Enviro Score	Group	Group Cost ($Million)
Tehachapi	30,947	Carrizo	20	Carrizo	$78
Imperial	22,219	BarrenRidge	77	LEAPS	$162
IronMt	10,928	Inyo	88	BarrenRidge	$208
Riverside	8,756	Tehachapi	97	Pisgah	$588
Pisgah	8,411	IronMt	131	Inyo	$656
MtPass	6,885	LEAPS	246	Tehachapi	$728
NorthEast	5,055	MtPass	252	NorthEast	$735
LEAPS	4,753	Pisgah	396	MtPass	$798
BarrenRidge	4,618	North	401	IronMt	$832
North	3,536	Riverside	419	Riverside	$1,081
Inyo	2,880	NorthEast	600	Imperial	$1,311
Carrizo	2,351	Imperial	837	North	$3,898
Median	**5,970**	**Median**	**249**	**Median**	**$731**

Foundation lines, Renewable Delivery lines and Renewable Collector lines are shown on the map in Figure 1-2.

Figure 1-1. Foundation Lines, Delivery Lines and Renewable Collector Lines.

2.2.2. Environmental Assessment

Factors Considered

Conceptual planning usually considers only potential electrical connections between substations, without regard to geographic factors. The first steps in the RETI planning approach, in contrast, are to exclude even potential transmission facilities (referred to as "conceptual" facilities) from being considered on lands where development is prohibited by law or policy, and to avoid environmentally sensitive lands. RETI Phase 1 work referred to these as Category 1 (Black) and Category 2 (Yellow) lands, respectively.

As emphasized in the discussion of CREZ revision work, RETI review of environmental concerns associated with generation and transmission projects is necessarily limited to high-level screening. Nevertheless, the SSC believes that even preliminary assessments of environmental concerns associated with new transmission facilities can help evaluate the develop ability of line segments. This includes identifying those unlikely to be able to be permitted.

The CPWG, CRWG and EWG, working together, modified the configuration of several of the transmission components initially proposed for the statewide plan, to avoid sensitive areas and to make maximum use of existing and approved corridors. Interested stakeholders frequently attended collaborative working sessions.

Expert Panel

In addition to this initial environmental screening process, the CPWG and CRWG developed a methodology to quantify the level of environmental concern associated with every line segment. This considers the amount and type of new rights of way required and the extent of disturbance associated with construction of new facilities. In addition to these objective considerations, the CRWG convened panels of environmental experts, for Northern California and Southern California, to provide their collective professional opinion on environmental concerns and the extent to which these concerns could be mitigated. Line segment environmental data, the issues matrix used by the expert panels and panel members can be found online at [http://www.energy.ca.gov/reti].

Ranking Scheme

Environmental concerns are considerably more difficult to quantify than the factors used in the economic assessment. Nevertheless, some quantification of these concerns allows CREZs to be compared in a manner similar to economic ranking. The EWG assessment relies on publicly available data sources together with formulas which use the data to provide a numerical indication of the relative level of concern for each California CREZ for each of eight different criteria.

The numerical values are intended only to indicate relative levels of concern. Their relative magnitudes have been used for the limited purpose of comparing CREZs. Because these values are gross indicators of potential environmental concern rather than of actual environmental impacts, they should not be used for any other purpose.

Eight criteria were identified by the EWG for comparing the relative environmental sensitivity of the California CREZs, as described in Section 4 of the Environmental Assessment volume. In general, these criteria are designed to identify those CREZs which:

- Disturb the least amount of land per unit of energy output, including land needed to collect and transmit that energy to the existing transmission grid.
- Minimize potential conflicts with areas of special environmental concern.
- Minimize potential impacts on wildlife and significant species.
- Maximize the use of previously disturbed lands.

In addition to the CREZ information provided by Black & Veatch, statewide datasets were identified to provide a quantitative basis for evaluating each of the eight criteria chosen by the EWG. The EWG devised formulas to translate the appropriate data for each CREZ into quantitative values, the magnitudes of which are indicators of the level of environmental concern associated with each CREZ and each criterion. Lower values given by the formulas are taken to represent relatively less concern. These values provide the basis for ranking CREZs according to relative levels of environmental concern.

Lack of data prevented inclusion of criteria to evaluate several environmental concerns, including visual impacts and effect of project development on cultural resources. The extent, to which EWG formulas should express preference for development on disturbed land, and how such lands should be defined, remains problematic and controversial. For wind projects in particular, consensus could not be reached on how project footprint should be defined and applied in assessing their environmental effects.

The U.S. Department of Energy *20% Wind Energy by 2030* report (May 2008) found that wind projects in the U.S. directly disturb on average 2.5 percent-5 percent of total project lease area for turbine tower foundations, access roads and substations.[9] The EWG used the midpoint of this range, 3.5 percent of total project area, in its criterion used to assess generating project footprint. At the same time, EWG formulas for two criteria intended to assess effect on sensitive species (in buffer areas around CREZ and on wildlife corridors) use the full lease area of wind projects. This is the first instance in which the environmental effect of wind projects has been characterized as proportional to the entire project lease area. The wind industry takes strong exception to such formulas, pointing to the lack of data and systematic study of such impacts. These formulas should not be considered to establish a precedent for evaluating wind project impacts.

Throughout the process of developing the criteria formulas and devising the ranking methodology, identities of the CREZs remained unknown to EWG participants. This anonymity was essential to preserve the objectivity of the results. Sensitivities have been performed with

[9] U.S. Department of Energy, *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*, May 12, 2008, p.110. Available at: [http://www1.eere.energy.gov/windandhydro/].

modified formulas and ranking methodologies to ensure that the results are robust against minor changes.

The eight ranking scores for each CREZ were then summed to provide a total ranking score of relative environmental concern for each CREZ. The best-scoring CREZs sufficient to provide nearly 100,000 GWh per year in the environmental assessment are identified in Table 1-3 below:

Table 1-3. Environmental Ranking of California CREZs.

CREZ Name	Annual Energy (GWh/yr)	Cumulative Energy (GWh/yr)	Environmental Ranking Score
Imperial North-A	10,095	10,095	2.7
Twentynine Palms	1,944	12,038	2.8
Mountain Pass	6,942	18,980	3.9
Tehachapi	25,091	44,072	4.0
Fairmont	18,318	62,390	4.0
Pisgah-A	4,283	66,673	4.4
San Diego South	1,829	68,502	4.4
Imperial East	3,991	72,493	4.9
San Bernardino - Lucerne	10,722	83,215	4.9
Victorville-A	2,112	85,327	5.0
Iron Mountain	12,713	98,040	5.0

CREZs identified above are those in which EWG data and ranking methodology indicate that energy development may create fewer environmental concerns. Ranking scores are not intended to represent the level of concern in any individual project which may occur within a CREZ. The EWG CREZ ranking process is not intended in any way to prejudge or substitute for a thorough environmental review of proposed projects as required by CEQA or NEPA.

Instead, incorporating environmental factors into CREZ ranking is intended to anticipate potential concerns associated with energy development and the transmission facilities needed to access these areas, thereby facilitating approval. CREZs able to be developed at the least economic cost and least environmental concern present the strongest case for approval of new transmission facilities.

3.0 Project Outcomes

3.1. Phase 1 Report Overview

The *Phase 1B Final Report* is a high-level screening analysis that groups CREZs based on geographical proximity, development timeframe, shared transmission constraints, and additive economic benefits.[10] CREZs were ranked according to cost effectiveness, environmental concerns, development and schedule certainty, and other factors to provide a renewable resource base for California.

The economic and environmental ranking processes are based on two different concerns; the former attempts to minimize economic costs, while the latter attempts to minimize environmental concerns. Since the assessments are based on different metrics, it is impossible to develop a single formula for combining the two sets of results. The combined results are displayed in Figure 1-3 below.

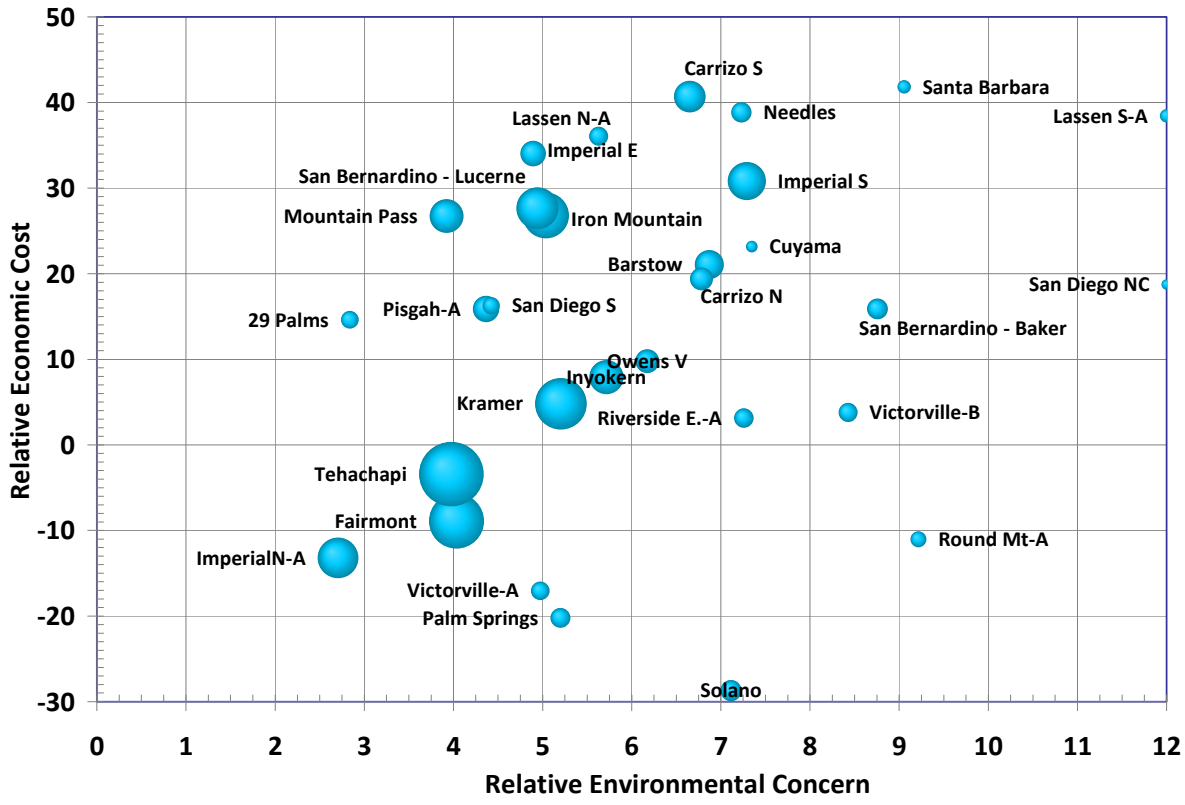

Figure 1-2. Economic and Environmental Assessment of California CREZs.

Circle size is proportional to CREZ energy potential (GWh/yr)

CREZs in the lower left section of the chart have the lowest (best) combination of economic and environmental ranking scores. These six CREZs have an estimated energy potential of 74,300

10 The Phase 1B Final Report is available on the RETI website at: [http://www.energy.ca.gov/reti/documents/index.html].

GWh/yr. It is noteworthy that three major transmission projects to access some of these areas are already being built or planned—the Tehachapi Renewable Transmission Project, whose first phase is under construction by Southern California Edison, the Sunrise Powerlink proposed by SDG&E, and Green Path North proposed by Los Angeles Department of Water and Power.

The CREZs in the lower right have economic ranking scores as low (good) as those in the lower left but have higher (worse) environmental ranking scores. The six CREZs grouped in this section of the chart are all relatively small, having a total estimated energy potential of about 19,500 GWh/yr. The extent to which major new transmission facilities would be needed to access these areas is to be examined by the Stakeholder Steering Committee.

CREZs in the upper left have environmental ranking scores comparable to those in the lower left but have higher (worse) economic ranking scores. The four CREZs clustered in this section of the chart have an estimated energy potential of 23,900 GWh/yr.

CREZs in the upper right received relatively poor ranking scores in both assessments. These 14 CREZs have an estimated energy potential of 53,600 GWh/yr. Two of these had environmental ranking scores higher than 12 and are shown on the edge of the chart.

Some additional general features of the assessment results can be seen in Figure 1-1. CREZs receiving lower (better) environmental ranking scores—those on the left hand side of the chart—tend to have more energy potential than CREZs receiving higher scores. Evidently the criteria used by the EWG favor larger and more energetic resource areas.

A second observation is that only eight of the CREZs assessed would be interconnected to the northern section of the California transmission grid.[11] All of these CREZs have relatively high environmental scores and appear on the right side of the chart. Of these only two—Solano and Round Mountain—received relatively good economic scores and appear in the lower right quadrant. The total energy potential of all eight CREZs is less than 20,000 GWh/yr, only 11 percent of the total, reflecting the fact that a large majority of the remaining undeveloped California high-density renewable energy potential is found in Southern California.[12]

3.2. Phase 2 Report Overview

RETI Phase 2 work focused on two major tasks:

1. Expand the evaluation and re-rank the CREZ preliminarily described in Phase 1.
2. Develop a statewide conceptual transmission expansion plan to access the CREZ.

The *Phase 2A Final Report* presented the results of these activities and the processes used to obtain them. It is divided into chapters on each major task.

---

[11] Carrizo North and South, Solano, Round Mountain, Santa Barbara, Cuyama, Lassen North and South.

[12] There are, however, significant biomass and solar photovoltaic resources in Northern California. These resources are generally distributed and do not require large transmission upgrades.

One of the primary functions of the *Phase 2A Final Report* is to provide a recommendation as to which potential transmission projects should be considered priorities for future study, based upon information available today regarding the potential for renewable development. These assumptions and the uncertainties surrounding them are detailed in the RETI *Phase 1B Report*.

The Phase 2A conceptual transmission plan is designed to facilitate meeting the goal of obtaining 33 percent of the state's electricity from renewables by 2020. But large investments in transmission infrastructure will be needed between now and 2020, regardless of the state's energy-supply mix. Many elements of the RETI conceptual transmission plan would likely be required under non-renewables-based planning scenarios. The estimates of the aggregate cost of the conceptual transmission plan presented in the report cannot be attributed only to the state's renewable-energy programs.

The conceptual transmission plan presented in the *Phase 2A Final Report* evaluates the relative usefulness of potential transmission lines for accessing and delivering renewable energy, under a limited set of assumptions. The report presents two noteworthy conclusions:

1. Stakeholder consensus recommendation of two sets of major lines likely to be required not only to deliver renewable energy, but that would provide important additional benefits to the grid.
2. Development of a transparent and objective methodology for evaluating the usefulness of lines to carry renewables, in a process that supports active participation by a broad range of stakeholders.

4.0 Conclusions and Recommendations

Sorting line segments into functional groups and applying the rating methodology summarized below produces the results shown on Table 1-2. Energy access scores, environmental scores, investment costs and detailed recommendations for each group of transmission projects are discussed in detail in the RETI *Phase 2A Final Report*.

With these rating results in mind, and considering also the detailed knowledge of the California grid and the diverse stakeholder perspectives that have been incorporated into the plan presented here, the RETI SSC recommends that:

1. The California ISO and POUs study Renewable Foundation lines and Renewable Delivery lines as soon as possible to determine which are needed, and when they should be placed in service to meet state goals by 2020.
2. In order to avoid duplicative or redundant facilities, California planning authorities work closely with one another to identify, propose, study and approve joint IOU-POU projects, and eliminate barriers to joint use of such facilities.
3. Multiple transmission charges be eliminated for purposes of all transmission line segments built primarily to access and deliver renewable energy in California, so that all transmission customers buying renewable energy sourced from California CREZ pay only one transmission charge. On joint IOU-POU transmission lines, for example, IOU customers would pay only the California ISO transmission charge, and POU customers would pay only a POU transmission charge; in neither case would a customer pay both California ISO and POU transmission charges.
4. The Energy Commission should begin immediately, per Public Resources Code §25331, to designate additional appropriate corridors, beyond those already established by federal agencies or utilities' rights of way, to reserve and protect transmission access to areas where renewable energy development is likely to occur, including likely routes for Renewable Foundation lines and Renewable Delivery lines. Corridor designation must be coordinated among state and federal agencies and support access to, for example, BLM Solar Energy Zones, and Desert Renewable Energy Conservation Plan (DRECP) generation development areas, as well as to the most likely CREZ.

In addition, specific recommendations regarding development of the Renewable Collector line groups shown on Table 1-2 are outlined in Chapter 3 of the RETI *Phase 2A Final Report*.

The conceptual plan described in this report is a work in progress. It identifies conceptual connections capable of delivering much more renewable energy than the RETI planning target of 160 percent of the estimated renewable net short. Future RETI work will prioritize and narrow down the number of line segments. The current plan includes line segments likely to be redundant, so some will be reconsidered; others may be added. CREZ data continues to be updated as more information becomes available on out of state resources, land use managers

amend their plans, and renewable development patterns change. Assessment results will continue to be updated so that mid-course corrections can be made in the future.

Despite the limitations inherent in CREZ and transmission element data and assessment methodology, the current plan provides a stakeholder-vetted basis for detailed planning by the California ISO and POUs. This detailed planning includes the contingency-based power flow modeling and economic grid simulations necessary to confirm the need for and cost-effectiveness of projects in the RETI conceptual transmission plan.

4.1. Benefits to California

Meeting California's renewable energy goals will require a substantial expansion of the state's electric transmission infrastructure. The crucial point for policymakers and the public is that transmission development leverages much larger investments in new generating resources. Transmission typically accounts for only a small percentage of the cost of the generation built to deliver energy over those lines. And the value of the energy delivered can replay the cost of the transmission investment quickly.[13] In addition, transmission lines approved for the primary purpose of delivering renewable generation to the grid will provide other benefits to consumers such as increased reliability, decreased congestion, and greater system efficiency.

[13] ERCOT 2006. *Analysis of Transmission Alternatives for Competitive Renewable Energy Zones in Texas.* http://www.ercot.com/news/presentations/2006/ATTCH_A_CREZ_Analysis_Report.pdf. ERCOT 2008 . *Competitive Renewable Energy Zone Transmission Optimization Study.* http://www.ercot.com/news/press_releases/2008/nr04-02-08. Quoted in US Department of Energy, *20% Wind Energy by 2030*, July 2008, p. 97: http://www.nrel.gov/docs/fy08osti/41869.pdf.

5.0 References

California Energy Commission. *Renewable Energy Transmission Initiative CEC 500-05-048 Scope of Work*, April 27, 2007.

California Energy Commission. *Renewable Energy Transmission Initiative Phase 1B Final Report*, posted January 5, 2009, publication #RETI-1000-2008-003-F, [http://www.energy.ca.gov/2008publications/RETI-1000-2008-003/RETI-1000-2008-003-F.PDF].

California Energy Commission. *Renewable Energy Transmission Initiative Phase 2A Final Report and Appendices*, posted September 23, 2009, publication #RETI-1000-2009-001-F-REV2, [http://www.energy.ca.gov/2009publications/RETI-1000-2009-001/RETI-1000-2009-001-F-REV2.PDF].

U.S. Department of Energy, *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*, May 12, 2008, p.110. Available at: [http://www1.eere.energy.gov/windandhydro/].

6.0 Glossary of Terms

Word	*Definition*
BLM	U.S. Bureau of Land Management
Energy Commission	California Energy Commission
CEQA	California Environmental Quality Act
CPUC	California Public Utilities Commission
CPWG	Conceptual Planning Working Group
CREZ	Competitive Renewable Energy Zone
CRWG	CREZ Revision Work Group
CSP	Concentrating Solar Power
DRECP	Desert Renewable Energy Conservation Plan
EWG	Environmental Work Group
GHG	greenhouse gas
GWh	Gigawatt Hours
IOU	Investor Owned Utility
ISO	Independent System Operator
kV	kilovolt
LSE	Load-Serving Entity
MW	Megawatt
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
PIER	Public Interest Energy Research
POU	Publicly Owned Utility
PSG	Plenary Stakeholder Group
RCRC	Regional Council of Rural Counties
RD&D	Research, development, and demonstration
RETI	Renewable Energy Transmission Initiative
RPS	Renewables Portfolio Standard
SB	Senate Bill
SCE	Southern California Edison Company
SDG&E	San Diego Gas & Electric Company
SSC	Stakeholder Steering Committee

7.0 Bibliography

California Energy Commission. *2007 Integrated Energy Policy Report*, CEC-100-2007-008-CMF.

California Energy Commission. Contract #500-05-048, *Scope of Work*, April 27, 2007.

Renewable Energy Transmission Initiative Mission Statement, April 1, 2009, at: [http://www.energy.ca.gov/reti/Mission_Statement.pdf.]

California Energy Commission. Contract #500-05-048. *Renewable Resource/Transmission Development Scenarios: Final RRZ Potential Meetings Report.* April 1, 2009.

California Energy Commission. Contract #500-05-048. *Renewable Resource/Transmission Development Scenarios: Final Potential RRZ Ranking Report.* May 29, 2009.

California Energy Commission. Contract #500-05-048. *Renewable Resource/Transmission Development Scenarios: First RRZ Conceptual Transmission Plan.* June 30, 2009.