2010 CTPG Revised Draft Study Plan for 2020: Phase 3

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1 Executive Summary

1.1 Background

The California Transmission Planning Group (CTPG) is a forum for conducting joint transmission planning studies consistent with Federal Energy Regulatory Commission (FERC) Order 890 principles, and for coordinating CTPG members' transmission planning activities. The CTPG members include both transmission owners and transmission operators and are subject to North American Electric Reliability Corporation (NERC)/Western Electricity Coordinating Council (WECC) transmission planning standards. The purpose of the 2010 CTPG Study for 2020 is to develop a state-wide transmission plan that identifies the transmission infrastructure needed to reliably and efficiently meet, by year 2020, the state's 33% Renewable Portfolio Standard (RPS) goal. The 2010 statewide plan is intended to be truly conceptual, not prescriptive. The CTPG is not a generation or transmission project decision-making body. The conceptual plan will require further consideration and analysis by the CTPG members that are planning entities for their Balancing Authority Areas as part of their own respective approval processes.

The CTPG is conducting its 2010 study in three phases. As reflected in this Phase 3 study plan, CTPG has sought to be responsive to stakeholders and other entities with roles in the planning and implementation of transmission development, including the Renewable Energy Transmission Initiative (RETI) and state energy agencies. The CTPG will continue to utilize several stakeholder involvement forums to receive this valuable input.

1.2 Overview

Transmission planning generally consists of three main elements: an estimate of the load that is expected in the planning horizon; modeling of the supply resources that are, or will be, interconnected to the transmission grid; and the identification of alternative transmission facilities that can meet reliability, economic, and policy objectives, such as the RPS. The 2010 CTPG Study for 2020 is drawing the information and methodological assumptions needed for transmission planning from several sources including California's RETI conceptual transmission plan that was developed to facilitate access to RETI-identified Competitive Renewable Energy Zones (CREZs), CTPG members, and other stakeholders. The CTPG is using this planning information and stakeholder input to develop and analyze a number of scenarios as a basis for a state-wide conceptual transmission plan. In turn, CTPG expects that the conceptual plan will provide the foundation for "least regrets" decisions in the subsequent planning phases by CTPG members.

Phase 1 of the 2010 study has concluded and the study results have been posted to the CTPG website after receiving the benefit of stakeholder input. The Draft Phase 2 Study Report has been posted to the CTPG website. Stakeholder input will be received at the April 20, 2010 CTPG Stakeholder Input Meeting in Sacramento and through written comments that will be accepted through April 28, 2010. This Phase 3 Study Plan is designed to build on the work completed in Phase 1 and Phase 2 and reflects stakeholder input by incorporating additional planning assumptions and scenarios to be studied in Phase 3. The Phase 3 Study Plan will also include a high-level analysis of any proposed stakeholder projects submitted to CTPG as alternatives to the transmission needs identified in the Phase 2 Study Report. Upon the completion of Phase 3, CTPG will provide a list of transmission needs identified for the bulk electric system including identification of those that could be least regrets by the standards of the CTPG study and the criteria set forth by other entities (such as RETI) . These needs will then be further analyzed and refined by the respective planning entities utilizing their own stakeholder processes.

A. Study Scope

In evaluating the performance of the transmission system with increased levels of renewable resources, it is important to understand and prepare for what may happen under adverse system conditions, as well as during expected system conditions. In Phase 3, like Phase 1 and Phase 2, the CTPG will conduct contingency-based power flow analysis and transient stability analysis of the grid configuration for the following cases that represent forecasted adverse and normal conditions:

Phase 3, like Phase 1 and Phase 2 includes variations of the following cases:

- Case A: 2020 Northern California adverse weather (1-in-10 Northern California peak coincident with a Southern California 1-in-2 peak) case
- Case B: 2020 Southern California adverse weather (1-in-10 Southern California peak coincident with Northern California 1-in-2 peak) case

Phase 3 will also include the following additional study case:

- Case F: 2020 California Autumn morning, light load

B. Grid Configuration

Like the Phase 1 and Phase 2 studies, the Phase 3 studies will utilize the WECC's 2019 Heavy Summer (HS) case. This base case is the latest available data for the WECC interconnected system for the 2020 time frame. A WECC full-loop representation will be used that includes the Western United States, Western Canada and the system of Comisión Federal de Electricidad (CFE) of Baja California, Mexico. As in Phase 2, at the request of stakeholders, the WECC HS will not include the Green Path Project which is no longer being considered by the LADWP. Similarly the WECC HS will include the addition of a recently approved third circuit to the Barren Ridge/Haskell Canyon/Renaldi planned upgrades.

C. Reliability Criteria

The CTPG will utilize NERC/WECC transmission planning standards to determine the list of potential transmission system violations that require mitigation. At this time, the CTPG will provide wire recommendations only. The CTPG will not be conducting a deliverability analysis to determine the necessary improvements and operating methodology for delivery of renewables to fulfill Resource Adequacy eligibility, and to provide integration capability for variable generation renewables, such as pumped storage or other methods. These types of analysis will be completed by the entity responsible for each particular proposed transmission improvement utilizing its own analysis assumptions. The CTPG may perform this type of analysis in future studies.

In addition, the CTPG will not be analyzing potential transmission need mitigation methods that may be provided by transmission line protection control systems. This analysis will be completed by the entity responsible for each particular proposed transmission improvement utilizing its own analysis assumptions and mitigation policies and practices. The CTPG may perform this alternative analysis in future studies.

D. Net Short Input Assumptions

In Phase 1, the CTPG members jointly identified the renewable energy resource additions and the "net short" energy requirements to meet the 33% RPS by 2020. In Phase 2, CTPG worked with RETI to update estimates of other miscellaneous renewable resource additions and clarifying other differences in assumptions to update the "net short" estimates that were applied to the renewable resource portfolios modeled in Phase 2. The CTPG used a "net short" of 52,764 GWh for Phase 2 modeling. In Phase 3, the CTPG will use the same "net short" estimate used in Phase 2 for all scenarios.

E. Renewable Generation Portfolios

The CTPG recognizes that there remains uncertainty about the final renewable generation portfolios that will be realized in 2020. To address this uncertainty, the CTPG has evaluated several alternative renewable generation portfolios as a basis for determining the impact of those alternatives on the state-wide conceptual transmission plan.

Phase 1. In Phase 1 the CTPG studied a renewable generation portfolio that was based on the commercial interest expressed by the CTPG member's Load Serving Entity Procurement Plans.

Phase 2. In Phase 2, in response to stakeholder input, the CTPG included two additional renewable generation portfolios. The first portfolio was a commercial interest portfolio of renewable generation based on the generation interconnection queues of CTPG members. This portfolio is referred to as the Generation Interconnection Queue Portfolio. From the CAISO queue, approximately 15,000 MW of resources were selected based on whether they have completed or are due to complete interconnection agreements or have otherwise posted financial security. The remainder of the CTPG planning entities, (IID, LADWP, SMUD, TANC, and TID), have selected approximately 3,000 MW of proposed projects that are considered to be the most advanced in their respective approval processes. The second portfolio in Phase 2 was developed through consultation with RETI. For the Phase 2 Study, RETI provided a "Heavy In-State" portfolio. This portfolio includes a "discounted core" of renewable energy resources with the remainder of the energy resources required to provide the "net short" comprising of 70% in-state and 30% out-of state energy resources. The "discounted core" consists of projects having power purchase agreements (PPAs) which have been approved by an appropriate regulatory entity *and* have filed an application for a permit to construct the project with appropriate permitting agencies. The in-state energy resources include (CREZs in California evaluated by

RETI as having the best estimated economic and environmental ranked scores. The out of state energy resources included CREZs evaluated by RETI as having the best economic ranked scores. The final energy attributed to each resource is computed on a pro rata basis for each CREZ included based on total estimated CREZ energy potential.

In addition to the Generation Interconnection Queue Portfolio and the RETI “Heavy In-State” studies, the CTPG also studied in Phase 2 several scenarios using the queue portfolio as a base. One scenario included the potential addition of 5000MW of Solar Photovoltaic in the Owens Valley Area. Also in response to stakeholder input, the CTPG studied a “Northern” scenario and a “Desert Southwest” scenario. These two portfolios were studied to identify the impact on the state’s transmission needs if some of the 33% RPS goal was achieved with additional renewable resources from northern California and out-of-state.

Phase 3. In Phase 3, the CTPG will continue to utilize the Generation Interconnection Queue portfolio developed in Phase 2 to conduct additional studies. Also in Phase 3, the CTPG has developed through consultation with RETI a “Best CREZ” portfolio. The “best” CREZs are those with the current best economic and environmental scores as determined in the RETI Phase 2A Report and subsequent evaluations by RETI. This portfolio will not explicitly include “discounted core” projects included in the Phase 2 RETI scenario. The “Best CREZ” portfolio also includes two CREZs that did not receive the highest economic and environmental scores in the RETI Phase 2A report. The first consists of 2539 MW of solar capacity in the Westlands CREZ, which has degraded land that potentially minimizes the environmental impact of renewable resource projects. The second consists of 454 MW of wind capacity at Solano, whose environmental score has been increased since the prior report. Table 4.4 shows the by-technology resources modeled in each CREZ for the RETI “Best CREZ” portfolio.

Also in Phase 3, the CTPG will continue studying the “Northern” scenario introduced in Phase 2. The Phase 2 report noted that the study results for this scenario exhibited significant unanticipated power flow results measured at the California-Oregon Border and recommended that additional studies for this scenario be conducted. The Phase 3 studies for the Northern Scenario will investigate methods that clarify these unexpected flows.

F. Generation Re-Dispatch

As renewable generation production is increased to reach 33% RPS, an equal amount of fossil fuel generation is re-dispatched (turned down or decremented) to balance load in each period modeled. Phase 1 studies used heat rate as the basis for re-dispatch, with high heat rate units turned down first. High heat rate generally translates to higher cost to generate electricity. Phase 2 continued to utilize this re-dispatch methodology and also considered a methodology based on fuel type as a proxy for re-dispatch to minimize carbon emissions. Phase 1 and Phase 2 employed a 70/30 split for the reduction of fossil fuel generation located within California and generation units located outside the state, respectively.

In Phase 3, the CTPG will continue to utilize the 70/30 in-state/out-of-state generation re-dispatch approach for most scenarios. However, the CTPG proposes to test the sensitivity of this assumption by utilizing an out-of-state re-dispatch method. This method will permit generation reductions across WECC based on fuel type and will not impose an in-state/out-of-state constraint. This will result in a re-dispatch primarily outside California. For generation reductions in the local capacity areas of California, this method limits reductions to levels above the local capacity requirement as identified by the California ISO. Generation units that are "must run units" located within the service territory of non-participating California ISO entities will also not be subject to re-dispatch.

G. Transmission Needs Alternative Analysis

The CTPG recognizes that stakeholders may identify potential alternative transmission project(s) that might fulfill the specified transmission needs identified in the Phase 2 Study Report. Therefore the CTPG has requested stakeholders provide specific information describing proposed transmission projects for comparison to transmission needs identified in CTPG studies. The request for alternatives and the template describing the required project details is available at the CTPG website. The requested information shall not be considered proprietary and will be provided to stakeholders. In order for the comparison studies to be consistent, the CTPG will use the scenarios developed in Phase 2 as basis for the power flow studies. The CTPG will evaluate the proposed stakeholder alternatives to determine the following:

- Does the alternative satisfy the transmission need identified in the CTPG studies?
- How does the electrical performance of the alternative compare to the transmission solution identified in the CTPG studies?

In addition, a high-level cost comparison and environmental review will be completed for stakeholder review.

H. Methodology Comparison to RETI Phase 2A

At the request of stakeholders, Section 6 of this study plan includes a comparison between the methodologies that were utilized in the RETI Phase 2A California conceptual transmission plan and those used by the CTPG in its Phases.

2 Phase 3 Study Plan Overview

2.1 Objectives

The CTPG is committed to developing a conceptual California state-wide transmission plan to meet, by year 2020, the state's 33% RPS goal. This transmission plan will seek to leverage a diverse portfolio of renewable energy generation technologies including wind, geothermal, small hydro, biomass and solar thermal and solar photovoltaic available to supply projected electricity demand in California from now to beyond 2020.

As reflected in this Phase 3 study plan, CTPG has sought to be responsive to stakeholders and other entities with roles in the planning and implementation of transmission development, including the Renewable Energy Transmission Initiative (RETI) and state energy agencies.

An important further qualification of the CTPG process and the state-wide conceptual plan that is being developed is that CTPG is not a transmission or generation project decision-making body. Such decisions will be made by the relevant CTPG members that are planning entities for their Balancing Authority Areas in accordance with their own processes for such decisions. Thus the 2010 statewide plan is intended to be truly conceptual, not prescriptive, in line with the CTPG role as a forum for statewide collaboration on planning. As such, the CTPG regularly requests and utilizes information from its members and from other state agencies on renewable projects that represent a snapshot of their respective generation interconnection queue processes, and has sought to make assumptions on how to aggregate such projects into a portfolio that achieves a state-wide 33% RPS. This snapshot is only being used to facilitate studies to determine potential state-wide transmission needs.

2.2 Study Scope

The CTPG is developing a state-wide transmission plan using multiple renewable resource portfolios and generation re-dispatch scenarios to determine the transmission system improvements that are needed to support the state's 33% RPS and maintain the transmission system reliability in accordance with industry standards. The 2010 CTPG 2020 study is being conducted in three phases. Each phase is intended to build on the previous phase by refining and adding additional scenarios and assumptions and testing the sensitivity of these scenarios and assumptions. At the completion of the 2010 CTPG Study, the CTPG expects to provide a list of transmission system improvements that can provide the basis for "least regrets" renewable transmission planning to the respective CTPG planning entities. These entities will then conduct operational, deliverability, and alternative analysis utilizing their respective policies and practices.

The identification of transmission system improvements that may be required by an expected change in generation resources or the grid configuration begins with snapshot analysis of grid performance under forecast system conditions. The North American Electric Reliability Corporation (NERC) Standards TPL-001 through -003 requires that the transmission system be "planned such that the Network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand levels over the range of forecast system demands". The CTPG will address the potential violations of NERC/WECC reliability standards at the network level only. Potential violation at the local load center level will be reported in the study and addressed by the entity responsible for local load center reliability. For the initial phase of the CTPG work, on- and off-peak studies were conducted to help frame system needs while accommodating increased renewable resource development. In evaluating the performance of the transmission system with increased levels of renewable resources, it is important to understand and prepare for what may happen under adverse system conditions, as well as during expected system conditions. Adverse conditions include high load hours when solar output will be at peak levels. Adverse conditions may also occur during lower load hours when wind generation is high but the amount of on-line dispatchable generation is relatively low. By testing a range of possible resource scenarios, in each phase across these same cases, the most accurate statewide transmission plan will be developed.

Phase 3 (like Phase 2 and Phase 1) includes variations of the following cases that represent forecasted adverse and normal conditions:

- Case A: 2020 Northern California adverse weather (1-in-10 Northern California peak coincident with a Southern California 1-in-2 peak) case
- Case B: 2020 Southern California adverse weather (1-in-10 Southern California peak coincident with Northern California 1-in-2 peak) case

Phase 3 will also include the following additional study cases:

- Case F: 2020 California Autumn morning, light load

Cases A, B, and F include those transmission additions that are in the WECC 2019 Heavy Summer seed case as well as certain transmission elements that will allow for the interconnection of new renewable resources. Case A, B, and F assume that major upgrades are built including Midpoint-Devers-Valley, Tehachapi Segments 1-11, the Barren Ridge/Haskell Canyon/Rinaldi upgrades, upgrades in the Owens Valley.

The studies for the cases will be performed using the following general steps.

Step 0: Develop Benchmark Base Case

- WECC 2019 cases as seed for scenarios
- Reflect transmission system configuration expected in 2020
- Update California demand according to scenario
- Re-dispatch path flows according to scenario
- Perform detailed contingency analysis to confirm reliability criteria is met

Step 1: Add Renewable Projects

- Model renewable projects at 0 MW output – CAISO and POU queue projects
- Modify grid to provide CREZ connections – Gen-tie and collector lines
- Perform detailed contingency analysis to confirm reliability criteria is met

- Identify and review limiting constraints or violations

Step 2: Dispatch Renewable Projects

- Dispatch renewable projects to anticipated output for each scenario
- Decrease an equal amount of fossil fuel generation
- Perform detailed contingency analysis to meet reliability criteria
- Identify and review limiting constraints or violations
- Identify transmission additions that will mitigate identified reliability criteria violations. These additions may include elements of the RETI Phase 2A conceptual transmission plan.

The case nomenclature uses a letter designation for scenarios followed by a number representing the particular step. Case A0 for example would be Scenario A with the modeling required in Step 0.

Case A2 will assess additional transmission that will mitigate identified reliability criteria violations during a northern California 1-in-10 year peak coincident with a southern California 1-in-2 year peak assuming 33% RPS goals are met but without stressing path flows. Case B2 will assess additional transmission that will mitigate identified reliability criteria violations for a southern California 1-in-10 year peak coincident with a northern California 1-in-2 peak assuming 33% RPS goals are met but without stressing path flows. Case F will be use the CTPG member forecasted peak data for a typical September, 2020 day at 9:00 AM. Case F is intended to study system stress conditions that may be expected from a September morning which will include high wind generation output, morning solar generation output, and a light load.

Cases A, B, and F may also identify certain Category C reliability criteria violations and that further study is required to identify suitable mitigation, such as controlled load drop and/or generator tripping, for these conditions. However, the CTPG has decided it will not evaluate the feasibility of such operation measures (See Section 3.1 Reliability Criteria for this discussion.) It is important to note these cases do not assess deliverability of off-peak conditions.

2.3 Grid configuration

Similar to Phase 1 and Phase 2, the Phase 3 studies will be performed using the WECC's 2019 Heavy Summer case. This case is the latest available data for the WECC interconnected system for the 2020 time frame. A WECC full-loop representation will be used; and includes the Western United States, Western Canada and the system of Comisión Federal de Electricidad (CFE) of Baja California, Mexico.

As part of the study process some adjustments are anticipated between phases. For Phase 2 the following adjustments are to be implemented:

- Removal of the proposed Green Path North project. LADWP has stated that this project will not be pursued.

- The addition of a recently approved third circuit to the Barren Ridge/Haskell Canyon/Renaldi planned upgrades.

Table 2.1 lists the major transmission upgrades in the seed 2019 WECC Base Case that were assumed in-service for all CTPG cases in this study and subsequent additions and subtractions.

Table 2.1: Transmission Upgrades included in the 2019 "Heavy Summer" Seed Case and Transmission Additions/Subtractions made to the Seed Case

Upgrades with Key Regulatory Approvals and Environmental Permits	Upgrades without Key Regulatory Approvals and Environmental Permits	Upgrades Removed
-Tehachapi Segments 1-3 - Sunrise Powerlink project -Tehachapi Segments 4-11	- New Colorado River ("Midpoint") 500 kV substation looping in existing 500 kV Palo Verde-Devers #1 line. - 500 kV Colorado River-Devers #2 line - 500 kV Devers-Valley #2 line - Expand Barren Ridge 230 kV substation. Upgrade existing 230 kV Owens Gorge-Rinaldi line from Barren Ridge to Haskell Canyon with double circuit 230 kV towers. Add Barren Ridge-Haskell Canyon #2 line on open side of towers - Upgrade existing 230 kV Owens Gorge-Rinaldi line from Haskell Canyon to Rinaldi - Add 230 kV Castaic-Haskell Canyon #2 line on open side of towers - Loop existing 230 kV Coachella Valley-Devers line into Mirage substation creating 230 kV Mirage-Devers #2 line. - Reconductor 230 kV Mirage-Devers #2 line from 393 MVA to 494 MVA.	Green Path North

3 General Guidelines and Criteria

The CTPG will conduct contingency-based power flow analysis for the cases described in the previous section. The General Electric Positive Sequence Load Flow program (GE-PSLF) will be used in conjunction with in-house Engineer Programming Control Language (EPCL) routines to help analyze the study results.

3.1 Reliability Criteria

Like Phase 1 and Phase 2, the Phase 3 study will use the following study methodology and criteria:

1. In the pre-contingency state and with all facilities in-service, the Bulk Electric System (BES) shall demonstrate transient, dynamic, and voltage stability. Facility ratings shall not be exceeded and uncontrolled separation shall not occur.
2. Starting with all facilities in-service and following single and double contingencies, the BES shall demonstrate transient, dynamic, and voltage stability. Facility ratings shall not be exceeded and uncontrolled separation shall not occur.
3. The single contingency analysis shall meet requirements R2.2 and R2.3 of NERC Reliability Standard FAC-010-1.
4. The double contingency analysis shall meet the requirements R2.4 and R2.5 and Regional Differences E.1 of FAC-010-1.

NERC Standard FAC-010-1 (E.1 R.1.2.5) provides that for double contingencies, the controlled interruption of electric supply (load shedding), the planned removal of certain generators (generation dropping), and/or the curtailment of firm power transfers may be necessary to maintain the overall security of the interconnected transmission system. These system adjustments can be made either manually or automatically via protection control systems. The CTPG will not be performing an alternative analysis for mitigating the need for a new or upgraded transmission line with protection control systems in the 2010 study plan. This alternative analysis will be completed by the entity responsible for each particular proposed transmission improvement utilizing its own analysis assumptions and mitigation policies and practices. The CTPG may perform this type of analysis in future studies.

Similarly, the CTPG will not be conducting a deliverability analysis to determine the necessary improvements and operating methodology for delivery of renewables to fulfill Resource Adequacy eligibility, and to provide integration capability for variable generation renewables, such as through pumped storage or other methods. This analysis will be completed by the entity responsible for each particular proposed transmission improvement utilizing its own analysis assumptions. The CTPG may perform this type of analysis in future studies.

All Facilities must be operating within their applicable post-contingency thermal, frequency, and voltage limits. The only exceptions to remaining within applicable ratings are: 1) a common mode outage of two generating units connected to the same switchyard and 2) the loss of multiple bus sections as a result of bus-tie breaker failure or delayed clearing due to a single line to ground fault.

For double contingency analysis, the CTPG will monitor all elements at 200 kV and higher, plus any additional critical lower voltage elements to determine potential reliability standards violations. Study results will document all elements that demonstrate a thermal loading of the facility applicable rating at 100% and above.

The NERC/WECC standards provide a framework from which computer simulation studies will be performed to model forecasted system conditions and evaluate the system performance. The following standards will be used for reliability assessments and standards compliance:

1. NERC Reliability Standards
    - TPL-001: System Performance Under Normal Conditions
    - TPL-002: System Performance Following Loss of a Single BES Element

- TPL-003: System Performance Following Loss of Two or More BES Elements

2. WECC
    - Reliability Criteria For Transmission System Planning
    - Voltage Stability Criteria, Under voltage Load Shedding Strategy, and Reactive Power Reserve Monitoring Methodology
3. Each member's and balancing authority's specific planning criteria

3.2 Power Flow Contingency Analysis Guidelines

Power flow contingency analysis will be performed for each scenario consistent with the standards referenced in the previous section to identify thermal overload conditions. Note that additional contingencies may be added based upon engineering judgment for particular runs.

3.3 Transient Stability Analysis Guidelines

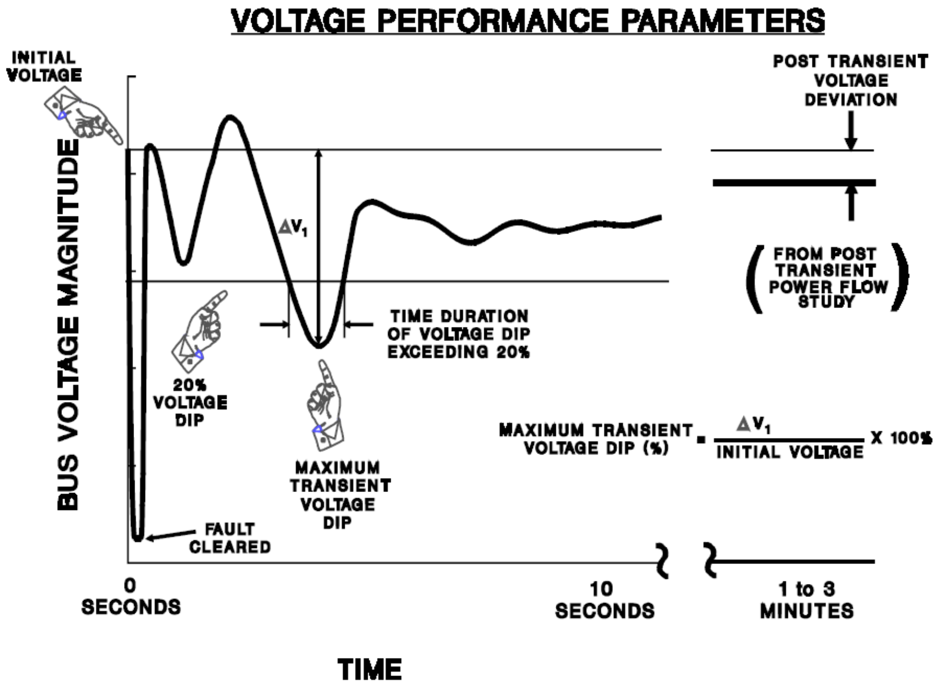
Transient stability studies will be performed to establish stability transfer limits and ensure system stability following a critical fault on the system and to facilitate the development of the dynamic voltage support requirements, if required.

- Machine Representation
    - For the stability analysis, resources consistent with the time period studied will be dispatched to meet the load requirements in the base cases. Representation of turbine generators will be consistent with available turbine generator data. The base case power system stabilizers that are normally in-service within the WECC system will be modeled for the Heavy Summer operating period studied. For new generator technologies that do not yet have specific representations, the study group will make reasonable assumptions and select the closest existing generator representation.
- Load Representation
    - Studies will be conducted with at least 20% of the total load represented in the WECC system as induction motor load.
- System Disturbances
    - All N-1 and credible N-2 system disturbances will be simulated.
- Fault Clearing Time
    - Faults on the transmission lines being evaluated will be cleared in accordance with guidelines provided by the facility owners.
- Under frequency Load-Shedding Simulated
    - The frequency will be monitored at key buses. If any stability run causes the frequency to drop sufficiently such that relays will "pick up", the under frequency load-shedding data will be reviewed and updated as necessary.
- Series Capacitors
    - Series capacitor modeling during transient conditions is indicated by the switching sequences.
- Unit Tripping
    - Unit tripping of other utility generation and pumping loads on under-frequency will be modeled in accordance with WECC guidelines or those provided by the appropriate facility owner.
- Generator Voltage Ride Through

  - Generator voltage ride through as per the WECC regional standard.
- Evidence of System Stability: The following WECC Disturbance-Performance criteria will be used:

Table 3.1 WECC Disturbance-Performance Table of Allowable Effects on Other Systems

NERC/WECC Categories	Outage Frequency Associated with the Performance Category (Outage/Year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard
A	Not Applicable	Nothing in addition to NERC		
B	≥0.33	Not to exceed 25% at load buses or 30% at non-load buses. Not to exceed 20% for more than 20 cycles at load buses	Not below 59.6 Hz for 6 cycles or more at a load bus	Not to exceed 5% at any bus
C	0.033 – 0.33	Not to exceed 30% at any bus. Not to exceed 20% for more than 40 cycles at load buses	Not below 59.0 Hz for 6 cycles or more at a load bus	Not to exceed 10% at any bus
D	< 0.033	Nothing in addition to NERC		



3.4 Voltage Stability Analysis Guidelines

Post-transient studies will be performed to ensure the WECC Voltage Stability Criteria will be met following credible outages within the system. Certain contingencies may activate Remedial Action Schemes (RAS)/Special Protection Schemes (SPS) which will be included in the switching sequences as appropriate. The post-transient voltage deviations shall meet the WECC/NERC Planning Standards except for SCE area which allows 7% voltage drop for N-1 contingencies.

The following assumptions apply to post-transient voltage stability studies:

- All loads will be modeled as constant MVA during the first few minutes following an outage or disturbance.
- Remedial actions such as generator dropping, load shedding and blocking of automatic generation control (AGC) will be considered as appropriate.
- Shunt capacitors (132 MVAR) at Adelanto and Marketplace will be used if the post-transient voltage deviation exceeds 5% at those buses. Although modeled as shunt capacitors the actual devices are automatically controlled SVCs.
- Shunt capacitors in the SCE service area will be modeled according to the SCE Centralized Grid Capacitor Control to be provided by SCE.
- All automatic switching will be allowed if the switching action can be completed within the post-transient study time frame.

4 Input Assumptions

This section describes the key input assumptions to the Phase 3 study plan, including the CTPG aggregate renewable energy planning target (net short), CTPG members' peak demands, and the new renewable generation portfolios and sensitivities to be studied.

4.1 Updates to the 2020 Renewable Energy Planning Target (Net Short)

In Phase 1, the CTPG identified the amount of renewable energy resource additions, "net short", that will be required between 2010 and 2020 to meet the 33% RPS goal for the state of California.[1] Further description of these assumptions is available in the CTPG Phase 1 study plan and final report. In Phase 2, CTPG worked with RETI to update estimates of other miscellaneous renewable resource additions and clarifying other differences in assumptions to update the net short estimates that will be applied to the renewable resource portfolios modeled in Phase 2.

Table 4.1 compares CTPG's Phase 1 study estimated renewable energy production and net short with the 2009 RETI Phase 2A calculation which utilized a prior CEC demand forecast for 2020, and hence is higher than the more recent CEC forecast used for the Phase 2 RETI "Heavy In-State" and CTPG Generation Queue estimates. Note that the energy and peak load numbers provided below reflect the CEC's projection of the impact of the California Solar Initiative (CSI), and other behind-the-meter distributed generation, on retail loads. Like Phase 2, to the extent any of CTPG's Phase 3 scenarios assume larger behind-the-meter impacts from distributed generation, or includes other in-front-of-the meter distributed generation, modeled loads in the power flow cases will be reduced accordingly.[2]

Table 4.1: CTPG 2020 RPS Planning Targets Including Net Short (GWh) with comparison to RETI Phase 2A

	CTPG Phase 1	RETI Phase 2A	CTPG Phase 2 RETI Heavy In State	CTPG Phase 2 Gen Queue
Forecast Retail Load subject to California's renewable goals:	289,697	301,974	285,734	285,734

[1] In Phase 1, CTPG used the 2020 energy forecast of the CEC's 2009 Integrated Energy Policy Report (IEPR), which resulted in an estimated 289,697 GWh of retail load in the state of California subject to the state's renewable goal. Under that assumption, assuming a 33% RPS goal in year 2020, load serving entities would be required to obtain a total of 95,600 GWh of renewable energy in order to meet the target, of which approximately 53,605 GWh would be acquired from resources over and above existing and new renewables and other miscellaneous additions – the net short. This net short requirement was modified in Phase 2, as described in this section and shown in the third and fourth column of Table 4.1.

[2] As noted elsewhere in this document, distributed generation poses modeling challenges that will eventually need to be addressed. For now, CTPG intends to simply model distributed generation by reducing loads.

Renewable Portfolio Standard (RPS) Goal:	33%	33%	33%	33%
Renewable Portfolio Standard (RPS) Energy Requirement:	95,600	99,651	94,293	94,293
Existing and New Renewables expected to be on line by end of 2009:	39,324	36,807	38,174	38,174
Miscellaneous renewable resource additions:	2,670	3,134	3,355	3,355
Total Existing and New Resource Additions	**41,994**	**39,941**	**41,529**	**41,529**
Net Short:	**53,605**	**59,710**	**52,764**	**52,764**
Identified Renewable Resource Additions:	55,535	95,536*	52,764	52,764
Total Renewable Energy Production:	97,530	135,477*	94,293	94,293
Identified Renewable Energy as a Fraction of Retail Sales:	33.7%	44.9%*	33%	33%

*For purposes of developing a conceptual transmission plan that addresses uncertainties in the location of renewable resource development, RETI Phase 2A planned for renewable resource additions equal to approximately 1.6 times the RETI Phase 2A net short.

4.2 Peak Demand

In Phase 1, CTPG used peak demand forecasts for "1-in-2" and "1-in-10" summer weather conditions in 2020 provided by the individual members. In Phase 3, like Phase 2, the scenarios modeled will use the assignments to each area used in the CEC IEPR 2009 forecast for peak demands consistent with the assumptions of the CTPG renewable net short calculation.[3]

Table 4.2 provides the data from the CEC peak demand forecasts for year 2020 for the Northern California Peak and the Southern California Peak. The Northern California Peak Demand includes the Northern California 1-in-10 year peak demand coincident with the Southern California 1-in2 year peak demand. The Southern California Peak includes the Southern California 1-in-10 year peak demand coincident with the Northern California 1-in-2 year peak demand. The adjusted Northern and Southern California Peak Demands consists of the CEC Peak Demand Forecasts excluding: pump loads, forecasted distributed generation (Digester and Landfill Gas, Small Hydro, PV, and other small capacity generation) assumed by RETI, and transmission losses.

Table 4.2: CTPG Phase 2 Year 2020 Peak Demand (MW) based on CEC 2009 forecast

[3] Available at http://www.energy.ca.gov/2009publications/CEC-200-2009-012/CEC-200-2009-012-SF-REV.PDF

Area	CEC Northern California Peak Demand	Adjusted Northern California Peak Demand	CEC Southern California Peak Demand	Adjusted Southern California Peak Demand
PG&E	26,423	24,606	24,626	22,924
TID BA	829	802	776	749
SMUD BA	5,679	5,450	5,196	4,972
SCE	26,875	25,127	29,359	27,604
SDG&E	5,157	4,937	5,673	5,435
LADWP BA	6,912	6,335	7,501	6,917
IID BA	1,256	1,253	1,354	1,349
Total	73,132	68,511	74,485	69,951

4.3 Renewable Generation Portfolios

CTPG recognizes that there remains uncertainty about the renewable generation portfolios that will be realized in 2020 under the State's RPS. To address this uncertainty, CTPG is evaluating several alternative renewable generation portfolios as a basis for determining the impact of those alternatives on the state-wide conceptual transmission plan. This section reviews the portfolios used in Phases 1 and 2 and then describes additional portfolios that will be examined in Phase 3. Additional information on the portfolios used in the prior phases can be found in the study plans and reports for each phase available on the CTPG website.

Review of CTPG Phases 1 and 2 Renewable Generation Portfolios

Phase 1 - California Load-Serving Entity (LSE) procurement plan portfolio. This portfolio was developed to reflect the initial preferences of the load serving entities supplying the majority of California retail loads. These entities provided renewable procurement scenarios reflecting anticipated plans, installed capacity, and in some cases the expected renewable dispatch at the time of peak. 4 In other cases CTPG used generic factors to relate nameplate capacity to expected renewable dispatch for the hour of study (e.g., peak hour, off-peak hour). These generic factors were taken from energy output profiles prepared for each of RETI's CREZs by technology for the specific hour and month. These hourly and monthly output profiles were also used to determine the forecasted annual energy generation estimate in the year 2020 by CREZ and technology. Rooftop PV and other distribution-level generation were considered as a

[4] Not all entities serving retail loads in California that are subject to California's renewable resource goals supplied renewable procurement plans to CTPG. CTPG's Phase 1 report lists those load serving entities that supplied renewable procurement plans to CTPG, and those that did not.

reduction to load. The CTPG members jointly identified the amount of renewable energy resource additions, the "net short", that will be required between 2010 and 2020 to meet the 33% RPS. Finally, as is evident from the data collected by the CTPG, California load serving entities' plans include adding renewable resources located in Idaho and Montana.

Phase 2 - Generation Interconnection Queue-based Portfolio. This portfolio utilized the renewable generation interconnection queues of CTPG members. The selection criteria used for the CAISO queue was to include projects in the following stages in their interconnection process: (1) For Serial interconnection studies (LGIP and SGIP) – All renewable projects with all interconnection studies completed and that have either signed or are in process of signing their interconnection agreement; (2) all remaining renewable projects in the ISO Transition Cluster (after posting of financial securities). The portfolio also added the proposed renewable generation projects and associated transmission for renewable energy projects considered to be the most advanced in their respective approval processes from the other CTPG planning entities (IID, LADWP, SMUD, TANC, and TID). For the CAISO queue, approximately 15,000 MW of resources were selected; the other CTPG planning entities selected approximately 3000 MW of resources.

The total annual renewable energy generation requiring transmission access used in this portfolio was set equal to a "net short" calculated by RETI, a value of 52,764 GWh.[5] The aggregate of the CAISO queue projects and the other state planning agency projects that met the selection criteria resulted in a 35% RPS. Therefore the CTPG scaled down all queue projects equally so that the aggregate of all proposed projects equaled 33%. The CTPG recognized that this scenario contained only approximately 8% of energy generated out-of-state. However, other scenarios studied in Phases 1 and 2 evaluated larger import levels and the associated impacts.

Phase 2 - RETI "Heavy In-State" Portfolio Phase 2. This portfolio was developed by RETI with contributions by the CPUC. Like the generation queue portfolio, the case was scaled to achieve the RETI net short. Renewable generation included in the scenario was identified from three categories: (a) a "discounted core" consisting of projects having power purchase agreements (PPAs) which have been approved by an appropriate regulatory entity and have filed an application for a permit to construct the project with appropriate permitting agencies; (b) Competitive Renewable Energy Zones (CREZ) in California having estimated economic and environmental ranking scores better than median California scores; and (c) out of state CREZ having economic scores better than the median out-of-state economic score (RETI has not attempted to compare environmental attributes of out-of-state areas). Finally, the energy needed in addition to the discounted core to satisfy the net short was (a) Divided 70/30 between in- and out-of-state areas; and (b) computed on a pro rata basis from CREZ included based on total estimated CREZ energy potential.

Phase 2 - "Northern" and "Desert Southwest" scenarios. The Generation Interconnection Queue Portfolio was used as the basis for two further portfolios with additional out-of-state resources: a "Northern" scenario and a "Desert Southwest" scenario. The Northern

[5] See http://www.energy.ca.gov/reti/steering/2010-01-19_meeting/documents/04-Net%20Short%20Draft%202010-01-18.pdf.

scenario assumed that renewable resources modeled in Northern California or north of California and committed to California load serving entities in Phase 1 were to change from 18% of total required renewable resources to about 42%. The Desert Southwest portfolio assumed that out-of-state renewable resources modeled in that region and committed to California load serving entities were to change from 2% of total renewable resources to about 15% of total renewable resources. In both scenarios, the renewable resources from the Generation Interconnection Queue Portfolio in Southern California were decremented on a pro-rata basis so that the aggregate of all proposed projects equaled 33%.

Phase 2 - Owens Valley development scenario. The Generation Interconnection Queue Portfolio was also used as the basis for a scenario in which 5000MW of installed capacity of Solar Photovoltaic at Owens Valley was substituted for other renewable resources in Southern California. The other Southern California renewable resources were decremented on a pro-rata basis so that the aggregate of all proposed projects equaled 33%.

Phase 3 – RETI "Best CREZ" Portfolio

In Phase 3, CTPG will continue being responsive to stakeholder requests in the formulation of new renewable resource portfolios to be modeled. In particular, CTPG will continue its engagement with RETI and model an additional RETI scenario, as selected by RETI. The RETI scenario consists of the "Best CREZs" as ranked by RETI and selected to supply 33% renewable energy. RETI CREZ ranking was refined over several phases of RETI work and consists of evaluating a broad set of economic and environmental criteria, which resulted in an economic "supply curve" and an environmental "supply curve" for the in-state and a few out-of-state CREZs. The best CREZs were those with the best economic and environmental scores; as an illustration of how RETI identifies preferred CREZs, the figure below, excerpted from the RETI Phase 2A report, shows the ranking of the CREZs by these scores (but not fully updated to reflect subsequent re-scoring). A difference between this RETI portfolio and the one modeled in CTPG Phase 2 is that this portfolio will not specifically require inclusion of the "discounted core" projects included in the Phase 2 RETI scenario. That is, some identified projects may overlap with the discounted core but the full set of the core projects is not carried over into this portfolio.

The CREZ economic score was composed of a number of criteria, including the energy value, capacity value and capital cost of the renewable resources. The costs of transmission were also estimated, but not included in the economic score due to concerns that the estimate was biased without further analysis.

With respect to the CREZ environmental score, as noted in RETI's Phase 2A final report, "CREZ identification includes high-level environmental screening that: 1) excludes certain areas from consideration as development sites, based on statutory or policy restrictions; and 2) indicates areas where energy development may create fewer environmental concerns, based on the best information available to the Environmental Working Group (EWG)."[6] The CREZ environmental ranking included the following core criteria for each CREZ: the size of the energy development

[6] RETI, Phase 2A Final Report, pg. 1-5; available at http://www.energy.ca.gov/2009publications/RETI-1000-2009-001/RETI-1000-2009-001-F-REV2.PDF.

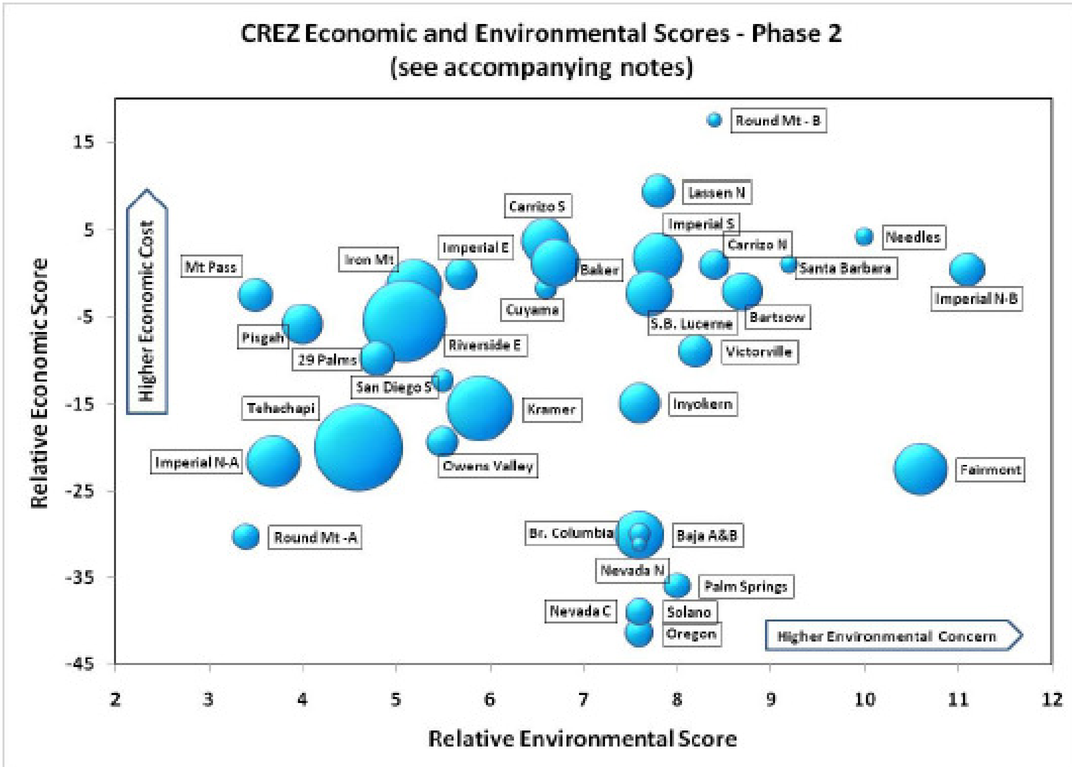
footprint, the size of the transmission footprint (i.e., land needed for transmission rights-of-way), the environmentally sensitive areas in the CREZ, the environmentally sensitive areas in CREZ buffer areas, the significant species in the CREZ, the wildlife corridors in the CREZ, important bird areas in the CREZ, and finally, whether transmission and generation siting could take advantage of degraded lands (such as abandoned mine lands, brownfields, and lands on which oil and gas development had occurred).[7]

RETI also notes certain qualifications on this determination, in that its environmental screening remains preliminary and cannot be taken as a definitive guide to the actual environmental impacts and regulatory implications encountered in any particular CREZ.[8]

As shown in Table 4.3, there are some significant differences between the RETI "High In-State" Portfolio modeled in CTPG Phase 2 and this portfolio. Carrizo South, Imperial South, Mountain Pass, Palm Springs, Round Mountain B, San Bernardino-Lucerne and Santa Barbara appeared in the former but not in the latter. On the other hand, this portfolio has over 2,000 MW of wind in Wyoming, which was not present in the prior RETI scenario. The RETI scenario also includes some CREZs not considered within the highest scoring areas in the RETI Phase 2A report. This includes 2539 MW of solar capacity in the Westlands CREZ, which has degraded land that potentially minimizes the environmental impact of the projects, and 454 MW of wind capacity at Solano, whose environmental score has been increased since the prior report. Table 4.4 shows the by-technology resources modeled in each CREZ.

[7] RETI, Phase 1B Final Report, pp. 4-1 to 4-6; available at http://www.energy.ca.gov/2008publications/RETI-1000-2008-003/RETI-1000-2008-003-F.PDF.

[8] RETI, Phase 2A Final Report, pg. 1-5.



Source: RETI Phase 2A Final Report, pg. 2-39.

Phase 3 – Generation Interconnection Queue-based Portfolio with Additional Sensitivities on Northern Scenario

In Phase 3, the CTPG will continue studies of the "Northern" scenario building on the efforts of Phase 2. The Phase 2 report noted that the study results for this scenario exhibited significant unanticipated power flow results measured at the California-Oregon Border and recommended that additional studies for this scenario be conducted. The Phase 3 studies for the Northern Scenario will investigate methods that clarify these unexpected flows.

4.4 Renewable Generation Production Profiles

As noted above in Phase 1 and Phase 2, CTPG used a combination of sources to establish production profiles for renewable resources. Based on the location of each CREZ, and the mix of renewable resources within each CREZ, CTPG members have developed estimates of the expected energy output of each CREZ for the specific study conditions assumed for the power flow cases. These estimates are based on actual hourly output data for similar technologies in similar locations.[9] In Phase 2, this information was updated by Black and Veatch to match the energy production profiles currently used by RETI. For study purposes, the CTPG utilizes the

[9]For a review of the production assumptions for each CREZ by renewable technology, see California ISO, "2020 Renewable Transmission Conceptual Plan Based on Inputs from the RETI Process Study Results," September 15, 2009, available at http://www.caiso.com/242a/242ae729af70.pdf .

expected average capacity factor for that resource type within that CREZ location. In contrast, RETI in their calculation utilizes the capacity factors for a specific project within each CREZ for inclusion in their scenario(s). This difference in approach, depending on CREZ location, will result in approximately 5% difference between CTPG and RETI annual energy output calculations. This difference is not considered significant to the comparison of study cases or scenarios.

Wind and solar generation modeled in the studies are represented as fixed production profiles. There is no consideration given in the analysis to dispatch control of renewable resource output (i.e., generation re-dispatch as discussed for fossil units in Section 6.1.), as may ultimately be needed to mitigate over-generation and congestion or ramp constraints on the rest of the generation fleet caused by variable renewable generation. Evaluation of renewable integration requirements will be completed separately by each planning entity.

Table 4.3: Comparison of Renewable Generation Portfolio for CTPG Phase 1, RETI Phase 2A, CTPG Phase 2-Generation Queue and RETI Heavy In-State, and CTPG Phase 3 RETI Best CREZ.

	CTPG Phase 1 Portfolio		RETI Phase 2A Portfolio*		CTPG Phase 2 Portfolio				CTPG Phase 3 Portfolio	
CREZ	LSE Commercial Interest Installed Capacity (MW)	LSE Commercial Interest Annual Renewable Energy Production (GWh)	RETI Projected Installed Capacity (MW)	RETI Projected Energy Production (GWh)	Generation Queue Installed Capacity (MW)	Generation Queue Annual Renewable Energy Production (GWh)	RETI Heavy In-State Installed Capacity (MW)	RETI Heavy In-State Annual Renewable Energy Production (GWh)	RETI Phase 3 Scenario Installed Capacity (MW)	RETI Phase 3 Annual Renewable Energy Production (GWh)
Barstow	850	1985	617	1546	0	0	0	0	0	0
Carrizo North	0	0	422	896	718	1532	0	0	0	0
Carrizo South	1545	3429	1024	2197	228	510	760	1616	0	0
Cuyama	0	0	211	471	37	78	0	0	0	0
Fairmont	345	862	929	2734	0	0	1126	2974	1346	3555
Humbolt	11	82	0	0	0	0	0	0	0	0
Imperial East	15	43	429	1045	0	0	0	0	0	0
Imperial North-A	352	2775	1370	10626	546	4305	631	4456	696	5126
Imperial North-B	386	1843	483	1190	418	901	0	0	0	0
Imperial South	466	1091	981	2420	2101	4990	300	648	0	0
Inyokern	242	467	642	1669	483	2552	0	0	0	0
Iron Mountain	0	0	1297	3065	0	0	0	0	0	0
Kramer	344	988	1693	4370	41	326	2724	6280	3256	7507
Lassen North	873	2262	387	999	463	3652	0	0	0	0
Lassen South	0	0	108	292	0	0	0	0	0	0
Mountain Pass	768	1777	438	1145	656	1475	310	800	0	0
Needles	0	0	122	313	0	0	0	0	0	0
Owens Valley	0	0	370	954	184	399	0	0	0	0
Palm Springs	147	500	203	685	183	624	37	118	0	0
Pisgah	3248	7763	673	1658	781	1867	500	1047	0	0

	CTPG Phase 1 Portfolio		RETI Phase 2A Portfolio*		CTPG Phase 2 Portfolio				CTPG Phase 3 Portfolio	
CREZ	LSE Commercial Interest Installed Capacity (MW)	LSE Commercial Interest Annual Renewable Energy Production (GWh)	RETI Projected Installed Capacity (MW)	RETI Projected Energy Production (GWh)	Generation Queue Installed Capacity (MW)	Generation Queue Annual Renewable Energy Production (GWh)	RETI Heavy In-State Installed Capacity (MW)	RETI Heavy In-State Annual Renewable Energy Production (GWh)	RETI Phase 3 Scenario Installed Capacity (MW)	RETI Phase 3 Annual Renewable Energy Production (GWh)
Riverside East	1562	3471	2785	6725	2527	5615	0	0	0	0
Round Mountain-A	0	0	101	710	94	253	163	1086	195	1298
Round Mountain-B	78	319	49	196	0	0	103	303	0	0
San Bernardino - Baker	825	1870	969	2299	0	0	0	0	0	0
San Bernardino - Lucerne	174	560	800	2150	0	0	42	96	0	0
San Diego	23	171	0	0	0	0	0	0	0	0
San Diego North Central	0	0	74	195	24	51	0	0	0	0
San Diego South	0	0	179	508	332	939	308	935	344	929
Santa Barbara	92	249	114	312	110	299	83	280	0	0
Solano	408	1248	236	756	587	1953	2	5	454	1382
Tehachapi	3868	10189	5514	15716	5633	15397	6026	15804	5294	12914
Twentynine Palms	0	0	477	1219	0	0	0	0	0	0
Victorville	0	0	432	1128	312	768	0	0	0	0
Westlands	0	0	0	0	0	0	0	0	2539	4223
Arizona	333	740	0	0	0	0	2048	5240	564	1376
Baja	0	0	5000	16966	1029	2704	0	0	0	0
British Columbia	0	0	340	1849	0	0	0	0	0	0
Idaho	130	350	0	0	0	0	668	2352	351	1327
Montana	413	1111	0	0	0	0	0	0	0	0

	CTPG Phase 1 Portfolio		RETI Phase 2A Portfolio*		CTPG Phase 2 Portfolio				CTPG Phase 3 Portfolio	
CREZ	LSE Commercial Interest Installed Capacity (MW)	LSE Commercial Interest Annual Renewable Energy Production (GWh)	RETI Projected Installed Capacity (MW)	RETI Projected Energy Production (GWh)	Generation Queue Installed Capacity (MW)	Generation Queue Annual Renewable Energy Production (GWh)	RETI Heavy In-State Installed Capacity (MW)	RETI Heavy In-State Annual Renewable Energy Production (GWh)	RETI Phase 3 Scenario Installed Capacity (MW)	RETI Phase 3 Annual Renewable Energy Production (GWh)
New Mexico	0	0	0	0	544	0	0	0		0
Nevada	456	2388	466	3446	0	1574	727	2476	187	1259
Oregon	1637	4408	392	3062	0	0	1349	3921	560	2035
Utah	0	0	0	0	0	0	255	905	322	1140
Washington	963	2594	0	0	0	0	447	1422	563	1793
Wyoming	0	0	0	0	0	0	0	0	2230	6899
Total	**20554**	**55535**	**30327**	**95536**	**18031**	**52764**	**18609**	**52764**	**18900**	**52764**

* For purposes of developing a conceptual transmission plan that addresses uncertainties in the location of renewable resource development, RETI planned for renewable resource additions equal to approximately 1.6 times the RETI net short.

Table 4.4: RETI Best CREZ Portfolio

	Install Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	Total
Arizona – Mountain Pass	33	529	3	0					87	1271	18	0	1376
Arizona – Riverside East	0	0	0	0					0	0	0	0	0
Baja-A (La Rumorosa)	0	0	0	0					0	0	0	0	0
Baja-B (Santa Catarina)	0	0	0	0					0	0	0	0	0
Barstow	0	0	0	0					0	0	0	0	0
British Columbia	0	0	0	0					0	0	0	0	0
Carrizo North	0	0	0	0					0	0	0	0	0
Carrizo South	0	0	0	0					0	0	0	0	0
Cuyama	0	0	0	0					0	0	0	0	0
Fairmont	361	914	70	0					1011	2048	496	0	3555
Idaho	248	0	54	49					640	0	365	322	1327
Imperial East	0	0	0	0					0	0	0	0	0
Imperial North-A	0	0	0	696					0	0	0	5126	5126
Imperial North-B	0	0	0	0					0	0	0	0	0
Imperial South	0	0	0	0					0	0	0	0	0
Inyokern	0	0	0	0					0	0	0	0	0
Iron Mountain	0	0	0	0					0	0	0	0	0
Kramer	103	3141	0	12					227	7199	0	81	7507
Lassen North	0	0	0	0					0	0	0	0	0
Lassen South	0	0	0	0					0	0	0	0	0
Mountain Pass	0	0	0	0					0	0	0	0	0
Needles	0	0	0	0					0	0	0	0	0
Nevada – Mountain Pass	0	0	0	0					0	0	0	0	0

	Install Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Total**
Nevada – Owens Valley	0	0	20	167					0	0	139	1120	1259
New Mexico	0	0	0	0					0	0	0	0	0
Oregon	437	0	62	60					1174	0	429	432	2035
Owens Valley	0	0	0	0					0	0	0	0	0
Palm Springs	0	0	0	0					0	0	0	0	0
Pisgah	0	0	0	0					0	0	0	0	0
Riverside East	0	0	0	0					0	0	0	0	0
Round Mountain-A	0	0	0	195					0	0	0	1298	1298
Round Mountain-B	0	0	0	0					0	0	0	0	0
San Bernardino - Baker	0	0	0	0					0	0	0	0	0
San Bernardino - Lucerne	0	0	0	0					0	0	0	0	0
San Diego North Central	0	0	0	0					0	0	0	0	0
San Diego South	344	0	0	0					929	0	0	0	929
Santa Barbara	0	0	0	0					0	0	0	0	0
Solano	454	0	0	0					1382	0	0	0	1382
Tehachapi	1621	3654	19	0					4608	8173	133	0	12914
Twentynine Palms	0	0	0	0					0	0	0	0	0
Utah	252	0	14	56					667	0	94	379	1140
Victorville	0	0	0	0					0	0	0	0	0
Washington	490	0	74	0					1290	0	503	0	1793
Westlands	0	2539	0	0					0	4223	0	0	4223
Wyoming	2230	0	0	0					6899	0	0	0	6899
Total	**6573**	**10776**	**314**	**1236**					**18915**	**22914**	**2176**	**8759**	**52764**

Table 4.5: Generation Interconnection Queue Portfolio

	Install Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	Total
Baja-A (La Rumorosa)	1029	0	0	0	311	0	0	0	2704	0	0	0	2704
Baja-B (Santa Catarina)	0	0	0	0	0	0	0	0	0	0	0	0	0
Barstow	0	0	0	0	0	0	0	0	0	0	0	0	0
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo North	0	703	15	0	0	580	13	0	0	1416	116	0	1532
Carrizo South	0	221	7	0	0	184	7	0	0	452	58	0	510
Cuyama	0	37	0	0	0	30	0	0	0	78	0	0	78
Fairmont	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial East	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial North-A	0	418	0	0	0	264	0	0	0	901	0	0	901
Imperial North-B	0	0	0	546	0	0	0	491	0	0	0	4305	4305
Imperial South	91	1952	58	0	27	1176	52	0	239	4293	457	0	4990
Inyokern	0	230	0	253	0	169	0	228	0	555	0	1997	2552
Iron Mountain	0	0	0	0	0	0	0	0	0	0	0	0	0
Kramer	0	0	0	41	0	0	0	37	0	0	0	326	326
Lassen North	0	0	0	463	0	0	0	417	0	0	0	3652	3652
Lassen South	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Pass	0	656	0	0	0	432	0	0	0	1475	0	0	1475
Needles	0	0	0	0	0	0	0	0	0	0	0	0	0
Nevada C	0	0	0	57	0	0	0	51	0	0	0	449	449
Nevada N	0	487	0	0	0	359	0	0	0	1127	0	0	1127
Oregon	0	0	0	0	0	0	0	0	0	0	0	0	0
Owens Valley	0	184	0	0	0	114	0	0	0	399	0	0	399
Palm Springs	183	0	0	0	103	0	0	0	624	0	0	0	624
Pisgah	0	781	0	0	0	583	0	0	0	1867	0	0	1867

	Install Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Total**
Riverside East	0	2527	0	0	0	1644	0	0	0	5615	0	0	5615
Round Mountain-A	94	0	0	0	22	0	0	0	253	0	0	0	253
Round Mountain-B	0	0	0	0	0	0	0	0	0	0	0	0	0
San Bernardino - Baker	0	0	0	0	0	0	0	0	0	0	0	0	0
San Bernardino - Lucerne	0	0	0	0	0	0	0	0	0	0	0	0	0
San Diego North Central	0	24	0	0	0	15	0	0	0	51	0	0	51
San Diego South	332	0	0	0	108	0	0	0	939	0	0	0	939
Santa Barbara	110	0	0	0	37	0	0	0	299	0	0	0	299
Solano	555	0	0	32	362	0	0	29	1699	0	0	254	1953
Tehachapi	3667	1966	0	0	2216	1460	0	0	10799	4598	0	0	15397
Twentynine Palms	0	0	0	0	0	0	0	0	0	0	0	0	0
Victorville	74	238	0	0	21	179	0	0	196	572	0	0	768
Total	**6135**	**10425**	**80**	**1393**	**3208**	**7190**	**72**	**1254**	**17750**	**23400**	**631**	**10983**	**52764**

Table 4.6: Northern Portfolio

	Installed Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	Wind	Solar Th.	Bio	Geo	TOTAL
Baja-A (La Rumorosa)	595	0	0	0	180	0	0	0	1563	0	0	0	1563
Baja-B (Santa Catarina)	0	0	0	0	0	0	0	0	0	0	0	0	
Barstow	0	0	0	0	0	0	0	0	0	0	0	0	
British Columbia	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo North	0	406	9	0	0	335	8	0	0	818	68	0	885
Carrizo South	0	128	4	0	0	106	4	0	0	261	34	0	295
Cuyama	0	21	0	0	0	17	0	0	0	45	0	0	45
Fairmont	0	0	0	0	0	0	0	0	0	0	0	0	
Imperial East	0	0	0	0	0	0	0	0	0	0	0	0	
Imperial North-A	0	242	0	0	0	153	0	0	0	521	0	0	521
Imperial North-B	0	0	0	316	0	0	0	284	0	0	0	2488	2488
Imperial South	53	1128	34	0	16	680	30	0	138	2481	264	0	2884
Inyokern	0	133	0	146	0	98	0	132	0	321	0	1154	1475
Iron Mountain	0	0	0	0	0	0	0	0	0	0	0	0	
Kramer	0	0	0	24	0	0	0	21	0	0	0	188	188
Lassen North	0	0	0	268	0	0	0	241	0	0	0	2111	2111
Lassen South	0	0	0	0	0	0	0	0	0	0	0	0	
Mountain Pass	0	379	0	0	0	250	0	0	0	853	0	0	853
Needles	0	0	0	0	0	0	0	0	0	0	0	0	
Nevada C	0	0	0	33	0	0	0	29	0	0	0	259	259
Nevada N	0	286	0	0	0	205	0	0	0	651	0	0	651
Oregon	0	0	0	0	0	0	0	0	0	0	0	0	
Owens Valley	0	106	0	0	0	66	0	0	0	231	0	0	231
Palm Springs	106	0	0	0	60	0	0	0	361	0	0	0	361
Pisgah	0	451	0	0	0	337	0	0	0	1079	0	0	1079
Riverside East	0	1461	0	0	0	950	0	0	0	3245	0	0	3245

	Installed Capacity (MW)				Dispatched (MW)				Energy (GWh)				
CREZ	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**Wind**	**Solar Th.**	**Bio**	**Geo**	**TOTAL**
Round Mountain-A	54	0	0	0	13	0	0	0	146	0	0	0	146
Round Mountain-B	0	0	0	0	0	0	0	0	0	0	0	0	
San Bernardino - Baker	0	0	0	0	0	0	0	0	0	0	0	0	
San Bernardino - Lucerne	0	0	0	0	0	0	0	0	0	0	0	0	
San Diego North Central	0	14	0	0	0	9	0	0	0	29	0	0	29
San Diego South	192	0	0	0	62	0	0	0	543	0	0	0	543
Santa Barbara	64	0	0	0	21	0	0	0	173	0	0	0	173
Solano	321	0	0	19	209	0	0	17	982	0	0	147	1129
Tehachapi	2120	1136	0	0	1280	844	0	0	6242	2658	0	0	8899
Twentynine Palms	0	0	0	0	0	0	0	0	0	0	0	0	
Victorville	43	138	0	0	6	12	0	0	113	331	0	0	444
Subtotal	3548	6029	47	806	1847	4062	42	724	10261	13524	242	6347	30550
Northwest	1508	0	0	0	360	0	0	0	4062	0	0	0	4062
Northern CA	1423	410	0	255	327	246	0	229	3687	2155	0	2010	7852
Northwest Shaped													10300
Total	**7699**	**6439**	**47**	**1061**	**2534**	**4308**	**42**	**953**	**18010**	**15679**	**366**	**8357**	52764

5 Transmission Needs Alternative Analysis

The CTPG recognizes that stakeholders may identify potential alternative transmission project(s) that may fulfill the specified transmission needs identified in the Phase 2 Study Report. Therefore the CTPG has requested stakeholders provide specific information describing proposed transmission projects for comparison to the transmission needs identified by CTPG studies. The request for alternatives and the template describing the required project details is available at the CTPG website. The requested information shall not be considered proprietary and will be provided to stakeholders. In order for the comparison studies to be consistent, the CTPG will use the scenarios developed in Phase 2 as basis for the power flow studies. The CTPG will evaluate the proposed stakeholder alternatives to determine the following:

- Does the alternative satisfy the transmission need identified in the CTPG studies?
- How does the electrical performance of the alternative compare to the transmission solution identified in the CTPG studies?

In addition, a high-level cost comparison and environmental review will be completed for stakeholder review.

6 Generation Re-Dispatch

6.1 Reduction Priority

As renewable generation production is increased, an equal amount of fossil fueled generation is required to be turned down (or decremented). Fossil generation was selected for reduction because of economics. With renewable generation mandated to occupy 33% of the electricity market in California, fossil generation must compete to remain in the market. The least efficient fossil units will be the most likely to shut down by 2020. Phase 1 studies used heat rate as the basis for reduction priority with high heat rate units backing down first. Generally, high heat rate translates into higher cost to produce electricity. CTPG will continue utilizing this methodology in Phase 3.

Another method to determine reduction priority is based on minimizing the carbon footprint, i.e., turn down units with the highest carbon emissions per megawatt-hour. Currently, legislation is being considered that would impose a carbon tax on fossil generation such that owners would need to make an economic decision whether to pay the tax and continue to operate, implement technical measures to reduce carbon emissions or retire the units. While there are many possible legislative methods to implement a carbon footprint minimization objective, none have been enacted.

CTPG will make an initial effort to simulate a carbon footprint minimization strategy using fuel type as a proxy. Obtaining timely carbon emissions data for power plants throughout the WECC was not feasible, however fuel type can be used as an approximation. Existing coal generation has the highest carbon footprint and under nearly any potential minimization strategy would be the first set of units to be decremented followed by oil and gas units. Within each fuel type the reduction priority will be based on heat rate. Heat rate is a measure of a generator's efficiency. Generators using the same fossil fuel can be ranked to estimate which units are likely to produce more greenhouse gases. A high heat rate would imply the burning of more fuel and therefore more emissions. This is only an approximation since the emission controls and the specific type of coal burned can be significant factors in determining green house gas emissions. Decrementing based on fossil fuel type is a proxy for reduction by carbon footprint until more data is available.[10]

Some fossil generation because of their location (i.e. must run or local capacity requirement) may provide local benefits which can override economic considerations. Renewable integration during real time operations may also require more fossil generation to remain on-line to address intermittency issues. Fossil generation developed as peakers may also remain in the generation fleet though they typically have higher heat rates. Although these are significant elements in precisely predicting which particular set of generators will be shut down by 2020 they may not be critical in the determination of the transmission upgrades required to meet a 33% RPS. The location of the renewable generation rather than the corresponding decremented fossil generation is a more significant factor in determining where reliability criteria violations are likely to occur and the set of "least regret" transmission additions that will mitigate the violations.

6.2 In State/Out of State

Phase 1 employed a 70/30 constraint in the reduction of fossil generation. Seventy percent of the decremented generation is located within California with thirty percent located outside the state. Phase 2 continued with this assumption for both the heat rate and fuel type methods.

Phase 3 will investigate removing the in/out of state constraint for the fuel type method, permitting the decrement of fossil generation across WECC based on minimizing carbon footprint for electricity production. CTPG recognizes that minimizing the carbon footprint requires a WECC wide approach. For example, a national carbon tax would apply equally to all fossil generation plants in the United States. If the carbon tax was sufficiently high, coal fired generation would cost more than other types of fossil generation and imposing an in/out of state constraint on the amount of coal fired generation that is decremented in response to the addition of renewable generation would not be coherent under a national carbon tax.

Decrementing coal fired generators outside of California to accommodate increased renewable generation within California could, for the first time, make California a net exporter of energy. This scenario may give rise to transmission reliability criteria violations entirely outside the state of California.

[10] We also note that stakeholders have proposed using a carbon tax to effect carbon reductions in the re-dispatch. One of the difficulties in this approach is deciding the level of the tax. To re-dispatch coal plants, such a tax would have to be sufficiently high. Nevertheless, this could be an alternative approach to emissions rates, although one that presumably would reach similar results.

6.3 Re-Dispatch Methods

Although Phase 2 continued to primarily utilize the heat rate method to reduce the output of fossil generation, the fuel type method was also employed to gauge the sensitivity in changing the required transmission additions. Heat Rate (Method 1) and Fuel Type (Method 2) are described in detail below. Out of State (Method 3) will be evaluated in Phase 3.

1. Heat Rate. Fossil generation is decremented in a merit-order fashion (least economic reduced first). This merit order was established through the use of heat rate data obtained from the WECC Transmission Expansion Planning & Policy Committee's (TEPPC's) 2017 economic database. A 70/30 (in/out of state) constraint is imposed for this method.

   Table 6.1 shows an example of the fossil generation decremented to offset the first block of renewable generation. This particular block is split 70/30 between units in California and those outside the state. Units in the block are decremented equally until all units in the block are turned off. Decrements below minimum output level are not allowed; i.e., the unit is turned off. Units in the next block are then reduced in the same fashion. Nuclear and hydro units are not decremented in the summer peak cases but could be reduced for the off peak cases.

Table 6.1: Fossil Generation Decrement Example - First Block

Internal (In California)			
Name	Unit	Nameplate (MW)	FL H.R. (mmBtu/MWh)
Mandalay	3	130	16.065
Ellwood	1	54	15.125
Olive	1	44	13.953
Long Beach	1	65	13.106
Long Beach	2	65	13.106
Long Beach	3	65	13.106
Long Beach	4	65	13.106
RAMCO OY	1	42	13.009
Grayson	8b	70	13.009
Goose	2	48	13.009
Lambie	1	48	13.009
	Total	**696 MW**	

External (Out of State)			
Name	Unit	Nameplate (MW)	FL H.R. (mmBtu/MWh)
Ocotillo GT1	1	56	14
Ocotillo GT2	1	56	14
Yucca CT1	1	19	14

External (Out of State)			
		Nameplate	
Yucca CT2	1	19	14
WPhx GT1	1	56	14
WPhx GT2	1	56	14
Reeves	1	40	13.613
	Total	**302 MW**	

2. Fuel Type. This method employs an approximation for determining which fossil generators will be decremented to minimize carbon emissions. This proxy method reduces generators based on fuel type. First to be decremented will be coal generators followed by oil and gas units. Within each fuel type the units with the highest heat rate is backed down first. Blocks of fossil generation are decremented to offset new renewable generation. Units in the block are decremented equally until all units in the block are turned off. Decrements below minimum output level are not allowed; i.e., the unit is turned off. Units in the next block are then reduced in the same fashion. A 70/30 (in/out of state) constraint is imposed for this method.

3. Out of State. This method employs an approximation for determining which fossil generators across WECC will be decremented to minimize carbon emissions. The 70/30 (in/out of state) constrained is not imposed for this method. This proxy method reduces generators based on fuel type throughout WECC. First to be decremented will be coal generators followed by oil and gas units. Within each fuel type the units with the highest heat rate is backed down first. Blocks of fossil generation are decremented to offset new renewable generation. Units in the block are decremented equally until all units in the block are turned off. Decrements below minimum output level are not allowed; i.e., the unit is turned off. Units in the next block are then reduced in the same fashion.

   It is expected that most, perhaps as much as 90%, of the generation reductions will be outside California. For generation reductions in the ten local capacity areas of California, this method limits reductions to levels above the 2014 local capacity requirement as identified by the California ISO. The California ISO report is available at:

   http://www.caiso.com/2495/2495c63b23450.pdf

   The following generation units located within the service territory of Los Angeles Department of Water & Power and the Sacramento Municipal Utility District BAA(s) will be considered must run units and will not be re-dispatch.

Table 6: LADWP and SMUD BAA Must Run Units

BUS NO.	GENERATOR NAME	ID
	LADWP	
26143	HARBCT10	10
26144	HARBCT11	11
26145	HARBCT12	12
26146	HARBCT13	13
26147	HARBCT14	14
26026	HAYNES1G	1
26027	HAYNES2G	2
26151	HAYNES8G	8
26152	HAYNES9G	9
26153	HAYNS10G	10
26112	SCATT1G	1
26067	SCATT3G	3
26148	VALLEY6G	6
26149	VALLEY7G	7
26150	VALLEY8G	8
	SMUD	
37320	UCDMC	1
37321	COSUMNE1	1
37322	COSUMNE2	1
37323	COSUMNE3	1
37303	CAMPBEL1	1
37304	CAMPBEL2	1
37310	PROCTER1	1

BUS NO.	GENERATOR NAME	ID
37311	PROCTER2	1
37312	PROCTER3	1
37315	SRWTPA	1
37315	SRWTPA	2
TID		
38570	WEC1-CT	1
38574	WEC2-CT	1
38572	WEC3-ST	1
38550	DONPDR01	1
38552	DONPDR02	1
38554	DONPDR04	1
38564	ALMONDCT	1
38560	LA GRNGE	1
38562	DAWSON	1

7 Methodology comparison to RETI

As noted above, transmission planning generally consists of three main elements: an estimate of the load that is expected in the planning horizon; modeling of the supply resources that are, or will be, interconnected to the transmission grid; and identification of alternative transmission facilities (upgraded or new transmission lines, substations, and so on) that can meet reliability, economic and policy objectives, such as RPS. The planning methodologies used to model future power system requirements can also vary.

At the request of stakeholders, this section compares the planning assumptions and methodologies used in the CTPG Phases 1, 2, and 3 with those used by RETI in their Phase 2A report. As noted in the prior CTPG study plans and reports, there are both similarities and differences between the CTPG and the RETI Phase 2A assumptions and methodology. This CTPG Phase 3 study plan reflects a further convergence in CTPG and RETI approaches, in that RETI has provided the estimates of future net load and renewable resource portfolio as inputs, while CTPG is conducting the transmission modeling.

7.1 Transmission System Analysis

One basic difference between the RETI Phase 2A transmission analysis and the CTPG approach is the level of transmission modeling used. RETI Phase 2A used input from RETI participants, including CTPG members, to identify potential transmission upgrades. However, this input did not have the benefit of power flow and transient analysis. RETI performed a "generation shift factor" analysis to determine the transmission needs for their proposed renewable resource plan. In contrast, the CTPG is performing power flow and transient analysis that is significantly more accurate at measuring the electric system performance and for determining transmission system needs.

There was some overlap between the transmission additions included in the RETI Phase 2A conceptual transmission plan and those identified in CTPG's Phase 1 conceptual transmission plan (see the 2010 Phase 1 CTPG 2020 Study Report for a comparison table of RETI Phase 2A and CTPG Phase 1 transmission elements).[11] This results in a smaller set of transmission elements than identified by RETI. CTPG studies will continue to provide those comparisons.

7.2 Net Short and Input Assumptions

When comparing CTPG Phase 1 to the RETI Phase 2A, both studies utilized CEC sources for the forecast of retail energy sales for the state. CTPG and RETI differed slightly in the estimates of expected renewable resources additions by the end of 2009. RETI Phase 2A also assumed that 160% of the renewable energy needed to achieve the 33% RPS should be modeled to account for potential uncertainties. The CTPG has instead identified sufficient renewable resources to achieve 33% RPS and then identified transmission elements that would mitigate identified reliability criteria violations with this amount of installed renewable generating capacity.

In terms of resources modeled, RETI Phase 2A developed its estimates based on economically feasible renewable development potential, rather than an actual commercial interest in that potential. In addition RETI considered out-of-state renewable resource development potential in British Columbia, Washington, Oregon, Nevada, Arizona and Baja. As is evident from the data collected by the CTPG in its Phase 1, California load serving entities' plans include adding renewable resources located in Idaho and Montana.

In CTPG Phase 2 and Phase 3, as discussed above, CTPG and RETI have converged in that they have agreed to use a common "net short" estimate. Also CTPG will continue modeling updated RETI renewable generation portfolios that, unlike Phase 2A, will be restricted to MW of renewable capacity needed to achieve a 33% renewable energy target.

[11] Available at http://www.ctpg.us/public/images/stories/pdfs/2010_phase_1_ctpg_2020_study_report_011310.pdf .