2010 CTPG DRAFT Phase 4 Study Report

December 30, 2010

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1 Executive Summary

Since the California Transmission Planning Group (CTPG) initiated its study effort in mid-2009, a primary objective of the Group has been to provide a foundation for a state-wide transmission plan that identifies the transmission infrastructure needed to reliably and efficiently meet the state's 33% Renewable Portfolio Standard (RPS) goal by the year 2020. Recognizing the complexity of the study effort, the CTPG has chosen to undertake a staged approach to achieve its objectives. In Phase 3 the CTPG developed a methodology for identifying an initial set of proposed "high potential" and "medium potential" transmission elements to be considered for inclusion in CTPG's state-wide plan. This approach involved ranking CREZs using publicly available measures of commercial interest and then evaluating the relative amounts of power from the highest ranked CREZs that could be expected to flow on each of the transmission infrastructure additions identified in CTPG's Phase 1, Phase 2 and Phase 3 studies. Those transmission infrastructure additions with the highest level of flow from these high ranked CREZs were deemed to be "high potential" transmission upgrades.

However, results from the Phase 3 analysis suggested that the initial set of "high potential" transmission elements identified in the Phase 3 study effort would not provide sufficient additional capacity to avoid reliability criteria violations at the full 33% RPS goal in year 2020. The CTPG based its conclusion on the fact that the "high potential" transmission upgrades are a small subset of the transmission upgrades identified in the Phase 1, 2 and 3 studies. In addition, measures of commercial interest used by CTPG to identify high ranking CREZs excluded renewable development plans by non-CPUC jurisdictional load serving entities and the potential for development of additional out-of-state resources. A number of these load serving entities serve retail loads in northern California and it is not clear that these entities intend to meet their respective renewable resource goals from renewable resource additions in southern California (where most of the renewables modeled in the CTPG studies were located). In addition, CTPG stakeholders have expressed a common opinion that there are other viable high commercial interest CREZs in-state and out-of-state which if appropriately considered, would provide for diversity in renewable resource locations and technology. While the Phase 3 effort brought a large number of issues to closure, the CTPG concurs with general stakeholder sentiment that some additional analysis is needed to fully "inform" the CTPG's statewide transmission plan. To this end, the CTPG Phase 4 Study was prepared to address the remaining work necessary before a fully "informed" statewide transmission plan to meet the 2020 RPS goals can be completed.

In Phase 4, with input from stakeholders, CTPG performed additional study work and conducted a survey of entities with knowledge of out-of-state renewable resource development potential and proposed inter-regional transmission projects. The information that was developed through these efforts has been used in considering whether the "high" and "medium" potential transmission upgrades documented in the final Phase 3 study report should be modified or augmented. The survey work included determining if there are other CREZs located within the state or renewable resource development areas outside the state that have commercial interest levels similar to the high ranking CREZs identified in Phase 3 and whether a revised renewable resource development pattern is in order. To the extent these determinations are in the affirmative, CTPG has made an assessment of whether previously undetected reliability criteria violations could arise and what transmission infrastructure additions not previously identified by CTPG would be effective in mitigating those violations.

1.1 Introduction

The California Transmission Planning Group (CTPG) is a forum for conducting joint transmission planning studies and for coordinating CTPG members' transmission planning activities. The CTPG members include both transmission owners and transmission operators, all of which are subject to North American Electric Reliability Corporation (NERC) Reliability Standards and Western Electricity Coordinating Council (WECC) Reliability Criteria. The purpose of the 2010 CTPG Study for 2020 is to develop a state-wide transmission plan that identifies the transmission infrastructure that could reliably and efficiently meet, by year 2020, the state's 33% Renewable Portfolio Standard (RPS) goal.

The CTPG has chosen to conduct its 2010 CTPG Study for 2020 in four phases. The Phase 4 Study builds on the work completed in Phases 1, 2 and 3 and reflects stakeholder input. Throughout the CTPG planning effort, 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), state energy agencies, and independent transmission and generation developers.

Regardless of how future procurement strategies develop, CTPG acknowledges that infrastructure additions into northern California, whether it is from southern California or the Pacific Northwest or northwest Nevada, will necessarily be based on the renewable resource development patterns and fossil-fired generation dispatch patterns that will exist following the addition of large amounts of renewable generation. As such, a more complete understanding of load serving entities' procurement strategies is needed before a final transmission plan for southern or northern California can be developed. CTPG has not attempted to gain such an understanding within the Phase 4 effort; rather CTPG has reviewed the viability of known northern California CREZs along with renewable resource development areas located in the Pacific Northwest and Northern Nevada. This information was used by CTPG to determine if there are additional "high potential" and/or "medium potential" transmission upgrades that should be considered, along with those presented by the CTPG in the Phase 3 Study Report, for inclusion in the 2010 state-wide transmission plan and further detailed study during the 2011 CTPG study effort.

1.2 Southern California "West of the River Stress" Analysis

In Phase 4, the CTPG stakeholders strongly suggested that the CTPG perform additional studies to assess the potential impacts associated with the delivery of much larger amounts of out-of-state renewable energy resources into California from southern Nevada and western Arizona. At the request of the CTPG, RETI has provided a proposed scenario that they have named the "West of the River Stress" scenario. The description of the proposed scenario provided by RETI is included in Appendix A of the final Phase 4 study plan. This scenario includes a "discounted core" and an out-of-state component from the southwest, with the remainder of the resources from the RETI's "Best CREZs". Table 1.1 shows the proposed resource contributions to the scenario.

Table 1.1: West of River Stress Scenario

Resource	GWhs/year	% Total
Discounted Core	20,905	40%
Southwest Out-of-State Imports	21,106	40%
California RETI Best CREZs	10,753	20%

Totals	**52,764**	**100.0%**

The "discounted core" consists of projects identified by the CPUC as 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 "discounted core" provided by RETI is the most current information from the CPUC. The southwest out-of-state imports include the injection of renewable energy resources at the Eldorado, Palo Verde, and North Gila 500-kV stations. Table 1.2 show the proposed injection amounts for the respective stations.

Table 1.2: Southwest Out-of-State Imports

500-kV Station	GWhs/yr	% Total
Eldorado	10,553	50%
Palo Verde	7,915	37.5%
North Gila	2,638	12.5%
Totals	**21,106**	**100%**

The remainder of the scenario consists of in-state energy resources evaluated by RETI in their Phase 2B Report as having the best estimated economic and environmental 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.

Similar to the southwest scenario studies completed in Phase 2, CTPG has performed four study cases in Phase 4 utilizing the RETI West of River (WOR) Stress Scenario.

- Case A: 2020 Northern California adverse weather (1-in-10 Northern California peak coincident with an approximate Southern California 1-in-2 peak) case
- Case B: 2020 Southern California adverse weather (1-in-10 Southern California peak coincident with an approximate Northern California 1-in-2 peak) case
- Case F1: 2020 Light Autumn Case with High WOR Flows
- Case F2: 2020 Light Autumn Case with WOR Flows of 6,700 MW

In the Phase 4 studies, CTPG used the same Net Short (52,764 GWh) provided by RETI for Phase 2 and Phase 3. The methodology used in Phase 4 for decrementing fossil fuel resource (re-dispatch) was also similar to the methodology used in Phase 2 and Phase 3. Specifically, the CTPG decremented fossil fuel generation with the least efficient heat rate units reduced first. Also in Phase 4, CTPG continued to utilize the 70/30 in-state/out-of-state generation re-dispatch approach. All other analysis methods, grid configuration, and reliability criteria are the same as those used in previous CTPG work.

1.3 "High Potential" Transmission Upgrades: Estimated Progress Towards Meeting California's 33% Renewable Portfolio Standard (RPS) Goal in Year 2020

In Phase 4, the CTPG analysis of the initial set of "high potential" transmission elements concluded that these elements could potentially provide transmission capacity to avoid reliability criteria violations when sufficient renewable energy is being generated to meet a California RPS of approximately 22% to 24% in year 2020. [1] The results showed that adding only the proposed "high potential" transmission upgrades to the existing transmission system would not provide enough transfer capability to allow all California load serving entities to meet their 33% RPS goals without potential reliability criteria violations. Perhaps more importantly, the Phase 4 analysis used to estimate the capability of the "high potential" transmission upgrades to accommodate renewable energy development indicates that the pattern of fossil generation redispatch significantly impacts the point at which increasing levels of renewable energy production will result in contingency-based reliability criteria violations. This analysis assumed that the output of fossil-fueled generation would be backed down based on full load heat rates. Full load heat rates are used as a proxy for the variable operating costs of fossil-fired generators. To achieve a load-resource balance with increasing renewable energy production, fossil-fired generators are backed down in reverse merit-order (starting with the highest variable operating cost units).

Since the amounts of renewables that can be accommodated by the "high potential" transmission upgrades without encountering reliability criteria violations is dependent upon the locations and amounts of renewable resources added and of fossil-fueled generation that is backed down, different resource addition/ generation back-down patterns would produce different results which could include a different set of high and medium potential transmission lines than the ones identified in the CTPG studies to date.

For example, if the back-down pattern was based on the fossil-fired generators that could mitigate reliability criteria violations that would otherwise be present, rather than on a strict reverse economic merit-order basis, the capability of the "high potential" transmission upgrades to support increased renewable resource development could exceed the estimated 22% - 24% RPS range. Note that out-of-merit order back down patterns may suggest that OTC units, or other inefficient generators in certain load pockets, not be retired with the result that generation from more efficient fossil-fired generation would have to be reduced in order to maintain a load-resource balance. Clearly, there are a number of variables such as state policy, cost, and/or environmental concerns that must be considered in determining the future disposition of less desirable generation. It should be noted that other preliminary studies conducted outside the CTPG forum utilizing out of merit order redispatch and other basecase assumptions have indicated that, with the addition of the high potential lines, the transmission grid may be capable of providing for the integration of sufficient renewables required to meet California's 33% RPS goal.

It should be emphasize that the intent of this analysis, albeit preliminary, was to consider the *capability* of the existing transmission system plus "high potential" transmission upgrades identified in Phase 3 to accommodate increased levels of renewable resource development. It should not be interpreted as implying anything about the *likelihood* that the procurement strategies of any load serving entity will occur as modeled in CTPG's analysis.

1.4 Identification of Additional High Commercial Interest CREZs

A major challenge in the development of a definitive transmission plan has been and continues to be the uncertainty of the location of the renewable resources since the state's load serving entities have not completed their respective final procurement decisions for meeting a 33% RPS, nor is it likely that those final procurement decisions will be within the next several years. In addition, there is also some uncertainty as to which of the renewable resource

[1] These studies have assumed that sufficient transmission infrastructure is in place to allow for the delivery of approximately 41,500 GWH of "-existing, under-construction and miscellaneous"- renewable resources

projects will be successful in obtaining permits and financing, the load serving entities procurement strategies are dependent on the outcome of legislation and rule making still being considered by state regulators and decision makers. These include green house gas reduction legislation; carbon emission levels [and renewable energy certificate rule making; state policy decisions on expanding energy efficiency, distributed generation, combined heating and power applications;, and decisions related to the disposition of coastal power plants using Once-through Cooling (OTC) technology.

In Phase 3, the CTPG identified high commercial interest CREZs by comparing the CREZs included in the "discounted core" portfolio assembled by the California Public Utilities Commission (CPUC) and the Generation Interconnection Queue portfolio assembled by the CTPG for the Phase 2 and Phase 3 studies. Specific CREZs that were found to be in both and within which there was an intersection of renewable generation technologies, were considered high commercial interest CREZs. These CREZs were used as a key input in the determination of the "high potential" and "medium potential" transmission elements proposed in Phase 3 Study Repot.

In Phase 4, the CTPG reviewed the commercial interest status of other in-state CREZs, including municipal utility renewable resource interests, and out-of-state renewable resource development areas. To assess the status of proposed out-of-state renewable energy development, the CTPG contacted Bonneville Power Administration (BPA), NV Energy (NVE), Arizona Public Service (APS), Salt River Project (SRP), New Mexico Public Service (PNM), the Western Area Power Administration – Desert Southwest Region (WAPA-DSW), and also received information from BC-Hydro, the Sierra Sub-regional Planning Group (SSPG) and the Southwest Area Transmission Planning Group (SWAT). The intent was to determine the relative status of the various interconnection requests in each party's generation interconnection queue and their respective transmission planning related to renewable energy delivery. The CTPG does not have access to relative PPA information associated with these proposed projects. The CTPG also reviewed publicly available information to determine the relative support provided at the state and federal level for the development of renewable energy resources in the western United States and the exporting of the energy to other states. The list of entities contacted was not intended to provide a complete inventory of activity in the west but rather an indication of what planning is underway, particularly adjacent to California. The CTPG understands that there are numerous other entities that are currently engaged in renewable energy planning and looks forward to exchanging information with these groups in the future.

In summary, the information provided by the out-of-state entities shows that many western states believe the development and export of renewable energy to be important to their respective states economic strategies and therefore have the support of private and government entities to work towards that end. The state's that were reviewed have significantly large generation interconnection queues that are well beyond their own RPS needs and some entities have already interconnected resources beyond their state's current requirements. Several states have developed conceptual transmission plans for the export of energy in the event the market requires addition transmission to collect and bring renewable energy to load centers. However, the CTPG does not believe the transmission upgrades associated with significant renewable energy imports from out-of-state should be designated as High Potential Transmission at this time. The amount of commercial interest demonstrated by California's load serving entities in the out-of-state renewable energy resources has not reached the levels modeled in Phase 3 or Phase 4.

Therefore, a more complete understanding of load serving entities' procurement plans or strategies is needed before a final state-wide transmission plan for California can be fully developed. In the interim, the CTPG has chosen to take a two step approach to developing a state-wide transmission plan. In additions to the High and Medium Potential transmission upgrades identified in Phase 3, the CTPG has developed a list of High Potential Transmission Corridors which are intended to provide CTPG members with potential transmission options for additional study in 2011.

1.5 Phase 4 High Potential Transmission Corridors

In Phase 4 the CTPG has developed ac criteria for identifying "high potential" transmission corridors and transmission upgrades within those corridors that may provide the State with options going forward in response to the uncertainty of the eventual locations of the renewable resources that will be procured by the state's LSEs. These options may prove useful in resolving key state policy decisions and rule makings. These transmission upgrades are also offered as potential options for providing access by California's entire load serving entities to in-state and out-of-state renewable resources that the High Potential transmission upgrades do not facilitate. In addition these upgrades may be useful as alternatives if the development of one or more "high ranked" CREZs does not move forward as planned.

The identification of high potential transmission corridors is intended to help California's load serving entities determine which renewable resource projects and procurement strategies make the most sense considering that renewable resource projects outside of the areas considered in CTPG's Phase 1 , 2 and 3 studies may have less environmental restrictions and be less costly to develop. This could reduce total procurement costs, i.e., combined generation and transmission costs. CTPG believes that the construction of transmission upgrades within the high potential transmission corridors will help to sustain a competitive renewable resource development and procurement environment as final procurement decisions are made by the State's load serving entities. Finally, the CTPG believes that additional renewable resource options should be explored because California will have additional renewable resource needs *beyond* 2020.

The following criteria have been selected by the CTPG for identifying high potential transmission corridors. These corridors will be included in the 2010 CTPG State-Wide Transmission Plan and will be subject to consideration and further study in 2011. Selected high potential transmission corridors must meet a majority of the criteria listed below.

- ***Criteria No. 1*** – The transmission corridor is associated with out-of-state transmission additions or upgrades currently being considered by other WECC planning entities for the delivery of renewable resources into California.
- ***Criteria No. 2 -*** The transmission corridor is associated with out-of-state transmission additions or upgrades that are known to be supported by federal and/or state government(s) for the purpose of developing and exporting renewable resources to California.
- ***Criteria No. 3 –*** The development of transmission additions or upgrades within the transmission corridor will facilitate a renewable resource portfolio for California that has geographical and weather (wind and sun) diversity.
- ***Criteria No. 4 –*** The development of transmission additions or upgrades within the transmission corridor will support the delivery of energy to California from out-of-state entities that are either developing or planning for the development of renewable resources well beyond their own needs.
- ***Criteria No. 5 –*** The development of transmission additions or upgrades within the transmission corridor will provide access to areas that have a successful record of renewable resource development.

1.6 Phase 4 High Potential Transmission Corridors Recommendations

Based upon study results in Phase 3 and the further analysis performed in Phase 4, the Pacific Northwest Corridor the Northwest Nevada Corridor, and the Southwest Corridor should be considered High Potential Transmission Corridors and warrant further study by the CTPG in 2011. These corridors are recognized as potential areas for the state of California to import power, including renewable energy to meet the state's RPS goals. The corridors have been selected for the following reasons:

- The recognition by other sub-regional planning groups for study as potential WECC transmission system improvements
- The potential for geographic, weather, and resource diversity for California's renewable resource portfolio beyond that provided by renewable developed primarily in southern California,
- The strong support by federal and state governments required for the completion of the renewable resource projects and transmission improvements that would provide renewable energy throughout the western United States.
- Potential access to entities that are currently planning for the development or renewable energy resources well beyond their own needs for potential import into California.

It is expected that as critical legislative, policy and rule-making decisions are made, and as the subsequent California LSE procurement decisions are made, the high potential transmission corridors and transmission upgrades within those corridors will be adjusted and the results reflected in a more definitive state-wide transmission plan.

1.7 2010 California State-Wide Transmission Plan

CTPG's 2010 Statewide Transmission Plan (2010 Plan) will facilitate the ability of the state to meet its 2020 RPS goal. The 2010 Plan will be based on the results, conclusions, and recommendations documented in the four phases of work performed by the CTPG during 2010. Like the preceding phases of the CTPG work, the 2010 Plan development process has included a stakeholder process to allow communication, coordination, and input from Stakeholders. The 2010 Plan will also include a report on the status of the CTPG members' respective transmission planning activities.

2 Phase 4 Study Plan Overview

2.1 Objectives

CTPG's 2010 Plan identifies the transmission infrastructure additions that, by year 2020, could allow the state to reach its 33% RPS goal without reliability criteria violations. This 2010 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 4 Study, 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 Plan is intended to be conceptual, not prescriptive, in line with the CTPG role as a forum for statewide collaboration on planning. As such, the CTPG has regularly requested and utilized information from its members and from other state agencies on renewable projects that represent a snapshot of their respective generation interconnection queue processes and renewable procurement plans, and has made assumptions on how to aggregate such projects into portfolios that achieve a state-wide 33% RPS. These snapshots are being used to facilitate studies to determine potential state-wide transmission needs.

2.2 Study Scope

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 Reliability Standards and WECC Reliability Criteria at the network level only. Potential violations 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.

Phase 4 (like Phase 1 through Phase 3) includes variations of the following cases that represent forecast adverse and normal conditions:

- Case A: 2020 Northern California adverse weather (1-in-10 Northern California peak coincident with an approximate Southern California 1-in-2 peak) case
- Case B: 2020 Southern California adverse weather (1-in-10 Southern California peak coincident with an approximate Northern California 1-in-2 peak) case
- 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 are included in Large Generator Interconnection Agreements (LGIAs) for various projects signed by the CAISO as well as certain projects identified by LADWP. Case A, B, and F assume that major upgrades are built including Colorado River-Devers-Valley #2, Tehachapi Segments 1-11, the Barren Ridge/Haskell Canyon/Rinaldi upgrades and 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 an approximate 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 an approximate 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 forecast 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 for 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 operational measures (See Section 3.1 Reliability Criteria for this discussion.) It is important to note these cases do not assess the "deliverability" of renewable resources for purposes of counting towards a CAISO load serving entity's CAISO Resource Adequacy (RA) requirements.

2.3 Grid configuration

As in previous phases, Phase 4 studies were performed using the WECC's 2019 Heavy Summer case. This case was the latest available for the WECC interconnected system for the 2020 time frame at the beginning of the CTPG study work. A WECC full-loop representation was 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 the following adjustments to the WECC base case were implemented in Phases 2 through 4:

- 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/Rinaldi 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. -	Green Path North

3 General Guidelines and Criteria

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

3.1 Reliability Criteria

Like the previous phases, the Phase 4 Study used the following study methodology and criteria:

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 Reliability Standards and WECC Reliability Criteria 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

Similarly, the CTPG did not conduct a deliverability analysis to determine the necessary improvements and operating methodology for delivery of renewables to fulfill the CAISO's Resource Adequacy eligibility requirements, 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 and assumptions. The CTPG may perform this type of analysis in future studies.

3.2 Power Flow Contingency Analysis Guidelines

Power flow contingency analysis was performed for each scenario consistent with the standards referenced in the previous section to identify thermal overload conditions. .

4 Input Assumptions

This section describes the key input assumptions to the Phase 4 study plan, including the CTPG aggregate renewable energy planning target (net short), CTPG members' peak demands, and the new renewable generation scenarios 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.[2] Further description of these

[2] 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

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. In Phase 4, the CTPG will utilize the same Net Short of 52,764GWhs. Like Phase 2 and Phase 3, to the extent any of CTPG's Phase 4 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 are reduced accordingly.[3]

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
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**

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.

[3] Distributed generation poses modeling challenges that will eventually need to be addressed. For now, CTPG intends to simply model distributed generation by reducing loads.

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 4, like Phase 2 and Phase 3, the scenario modeled used 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.[4]

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

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

4.3 Renewable Generation Scenarios

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 has evaluated 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 through 3 and then describes the additional scenario examined in Phase 4. 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, 2, and 3 Renewable Generation Scenarios

Phase 1 - California Load-Serving Entity (LSE) procurement plan scenarios. This scenario 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[5]. 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 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 Scenario. 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.[6] 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.

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[5] 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.

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

Phase 2 - RETI "Heavy In-State" Scenario. 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 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" Scenario. In Phase 3, the CTPG continued its engagement with RETI and modeled an additional RETI scenario. The RETI scenario consisted 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. A difference between this RETI portfolio and the one modeled in CTPG Phase 2 is that this portfolio did 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.

Phase 3 – Generation Interconnection Queue-based Scenario with Additional Sensitivities on Northern Scenario. In Phase 3, the CTPG continued studying 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.

Phase 4 – RETI West of River Stress Scenario. In Phase 4, in response to stakeholder's suggestions, the CTPG performed additional studies on the potential delivery of much larger amounts of out-of-state renewable energy resources imported into California from southern Nevada and western Arizona. At the request of the CTPG, RETI provided a proposed scenario that they have named the "West of the River Stress" scenario. The description of the proposed scenario provided by RETI is included in Appendix A of the final Phase 4 study plan. This scenario includes a "discounted core" and an out-of-state component from the southwest, with the remainder of the resources from RETI's "Best CREZs". Table 4.3 shows the proposed resource contributions to the scenario.

Table 4.3: West of River Stress Scenario

Resource	GWhs/year	% Total
Discounted Core	20,905	40%
Southwest Out-of-State Imports	21,106	40%
California RETI Best CREZs	10,753	20%
Totals	**52,764**	**100.0%**

The "discounted core" consists of projects identified by the CPUC as 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 "discounted core" provided by RETI is the most current information from the CPUC.

Table 4.4: West of River Stress Scenario Discounted Core

	Bio		Geothermal		Solar PV		Solar Thermal		Wind		TOTAL	
	MW	Est. GWh	MW	Est. GWh	MW	Est. GWh	MW	Est. GWh	MW	Est. GWh	MW	Est. GWh
Alberta		-		-		-		-	516	1,356	516	1,356
Arizona		-		-	290	635		-		-	290	635
Carrizo N/S		-		-	849	1,859		-		-	849	1,859
Fairmont		-		-	230	504		-		-	230	504
Imperial South		-	40	298	49	108	300	657		-	389	1,063
Kramer		-		-		-	250	548		-	250	548
Montana		-		-		-		-	300	788	300	788
Mountain Pass		-		-		-	410	898		-	410	898
Nevada C		-		-	50	110	400	876		-	450	986
New Mexico	32	140		-		-		-		-	32	140
NonCREZ	117	512		-	50	110	150	329		-	317	950
Northwest (OR, WA)		-		-		-		-	614	1,614	614	1,614
Palm Springs		-		-		-		-	77	202	77	202
Pisgah		-		-		-	500	1,095		-	500	1,095
Riverside East		-		-	550	1,205	492	1,077		-	1,042	2,282
Round Mountain		-		-		-		-	78	206	78	206
San Bernardino - Lucerne		-		-		-		-	42	110	42	110
San Diego South	21	92		-		-		-		-	21	92
Santa Barbara		-		-		-		-	83	217	83	217
Solano		-		-		-		-	38	100	38	100
Tehachapi		-		-		-		-	1,912	5,024	1,912	5,024
Utah-Southern Idaho		-		-		-		-	90	237	90	237
TOTALS	170	745	40	298	2,068	4,530	2,502	5,479	3,750	9,854	8,530	20,905
											OOS	5,755

The southwest out-of-state imports include the injection of renewable energy resources at the Eldorado, Palo Verde, and North Gila 500-kV stations.

Table 4.5: Southwest Out-of-State Imports

500-kV Station	GWh/yr	% Total
Eldorado	10,553	50%
Palo Verde	7,915	37.5%
North Gila	2,638	12.5%
Totals	**21,106**	**100%**

The remainder of the scenario consists of in-state energy resources evaluated by RETI as having the best estimated economic and environmental ranked scores. The final energy attributed to each resource is computed on a pro rata basis for each CREZ based on total estimated CREZ energy potential. Table 4.6 below compares the renewable resource generation scenarios for each of the CTPG study phases. Tables 4.7 and 4.8 provide, for the RETI West of River Stress Scenario, the installed capacity, dispatched capacity and annual energy production by location for the renewable resources included in (i) the A and B cases and (ii) for the F case.

Table 4.7: Renewable Resources in the "A" and "B" Cases

CREZ / Renewable Resource Development Location	Installed Capacity (MW) Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Dispatched Capacity at 4:00 pm PST in Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Annual Energy Production (GWh) Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Total
Barstow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo South	0	0	425	0	0	0	0	247	0	0	0	0	930	0	0	930
Carrizo South	0	0	425	0	0	0	0	247	0	0	0	0	930	0	0	930
Carrizo South subtotal	0	0	849	0	0	0	0	495	0	0	0	0	1,859	0	0	1,859
Cuyama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairmont	24	0	230	314	124	22	0	148	202	44	170	0	504	703	347	1,724
Imperial East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial North-A	0	239	0	0	0	0	215	0	0	0	0	1,759	0	0	0	1,759
Imperial North-B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial South	0	40	49	300	0	0	36	20	121	0	0	298	109	657	0	1,064
Inyokern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron Mountain	0	0	0	150	0	0	0	0	71	0	0	0	0	329	0	329
Kramer	0	4	0	1,328	35	0	4	0	937	10	0	28	0	3,018	78	3,124
Lassen North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lassen South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Pass	0	0	0	267	0	0	0	0	154	0	0	0	0	584	0	584
Mountain Pass	0	0	0	144	0	0	0	0	83	0	0	0	0	314	0	314
Mountain Pass subtotal	0	0	0	410	0	0	0	0	236	0	0	0	0	898	0	898
Needles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Owens Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palm Springs	0	0	0	0	77	0	0	0	0	28	0	0	0	0	202	202
Pisgah-A	0	0	0	500	0	0	0	0	352	0	0	0	0	1,095	0	1,095
Riverside East	0	0	413	369	0	0	0	244	219	0	0	0	904	808	0	1,712
Riverside East	0	0	138	123	0	0	0	81	73	0	0	0	301	269	0	571
Riverside East subtotal	0	0	550	492	0	0	0	326	292	0	0	0	1,205	1,077	0	2,282
Round Mountain-A	0	67	0	0	0	0	60	0	0	0	0	445	0	0	0	445
Round Mountain-B	0	0	0	0	78	0	0	0	0	21	0	0	0	0	207	207
San Bernardino - Baker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Bernardino - Lucerne	0	0	0	0	42	0	0	0	0	9	0	0	0	0	110	110
San Diego North Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Diego South	0	0	0	0	118	0	0	0	0	30	0	0	0	0	319	319
Santa Barbara	0	0	0	0	83	0	0	0	0	19	0	0	0	0	216	216
Solano	0	0	0	0	38	0	0	0	0	14	0	0	0	0	100	100
Tehachapi	5	0	0	878	1,728	4	0	0	559	618	32	0	0	1,963	4,623	6,618
Tehachapi	2	0	0	376	740	2	0	0	240	265	14	0	0	841	1,981	2,836
Tehachapi subtotal	6	0	0	1,254	2,468	6	0	0	799	882	46	0	0	2,804	6,605	9,455
Twentynine Palms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Victorville	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Westlands	0	0	50	0	0	0	0	33	0	0	0	0	110	0	0	110
San Diego (Border substation)	21	0	0	0	0	19	0	0	0	0	92	0	0	0	0	92
Sylmar	10	0	0	0	0	9	0	0	0	0	44	0	0	0	0	44
Stockton	45	0	0	0	0	41	0	0	0	0	197	0	0	0	0	197
McFarland	44	0	0	0	0	40	0	0	0	0	193	0	0	0	0	193
Petaluma	5	0	0	0	0	5	0	0	0	0	22	0	0	0	0	22
Hanford	2	0	0	0	0	2	0	0	0	0	9	0	0	0	0	9
Blue Lake	11	0	0	0	0	10	0	0	0	0	48	0	0	0	0	48
Alberta	0	0	0	0	150	0	0	0	0	62	0	0	0	0	394	394
Alberta	0	0	0	0	300	0	0	0	0	123	0	0	0	0	788	788
Alberta	0	0	0	0	66	0	0	0	0	27	0	0	0	0	173	173
Alberta subtotal	0	0	0	0	516	0	0	0	0	212	0	0	0	0	1,356	1,356
Arizona			290			0	0	159	0	0			635			635
Arizona					418	0	0	0	0	129					1,319	1,319
Arizona			510	417	772	0	0	280	358	238			1,319	1,319	2,639	5,277
Arizona			502	408		0	0	276	350	0			1,319	1,319		2,638
Arizona subtotal	0	0	1,302	824	1,191	0	0	714	709	368	0	0	3,273	2,638	3,958	9,869
Idaho	0	0	0	0	90	0	0	0	0	24	0	0	0	0	237	237
Montana	0	0	0	0	300	0	0	0	0	144	0	0	0	0	788	788
Nevada - South	0	0	1,051	1,281	386	0	0	441	972	113	0	0	2,748	3,515	1,319	7,582
New Mexico	32					27	0	0	0	0	140					140
New Mexico					772	0	0	0	0	249					2,639	2,639
New Mexico subtotal	32	0	0	0	772	27	0	0	0	249	140	0	0	0	2,639	2,779
Oregon	0	0	0	0	614	0	0	0	0	160	0	0	0	0	1,614	1,614
Oregon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon subtotal	0	0	0	0	614	0	0	0	0	160	0	0	0	0	1,614	1,614
Wyoming	0	0	0	0	717	0	0	0	0	370	0	0	0	0	2,639	2,639
TOTAL	200	350	4,081	6,853	7,650	179	315	2,177	4,691	2,696	960	2,530	9,808	16,734	22,732	52,764

Table 4.8: Renewable Resources in the "F" Case

CREZ / Renewable Resource Development Location	Installed Capacity (MW)					Dispatched Capacity at 9:00 am PST in					Annual Energy Production (GWh)					
	Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Biomass/ Biogas	Geo thermal	Solar PV	Solar Thermal	Wind	Total
Barstow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carrizo South	0	0	425	0	0	0	0	350	0	0	0	0	930	0	0	930
Carrizo South	0	0	425	0	0	0	0	350	0	0	0	0	930	0	0	930
Carrizo South subtotal	0	0	849	0	0	0	0	700	0	0	0	0	1,859	0	0	1,859
Cuyama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairmont	24	0	230	314	124	22	0	205	279	20	170	0	504	703	347	1,724
Imperial East	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial North-A	0	239	0	0	0	0	215	0	0	0	0	1,759	0	0	0	1,759
Imperial North-B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperial South	0	40	49	300	0	0	36	39	237	0	0	298	109	657	0	1,064
Inyokern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron Mountain	0	0	0	150	0	0	0	0	121	0	0	0	0	329	0	329
Kramer	0	4	0	1,328	35	0	4	0	1,197	4	0	28	0	3,018	78	3,124
Lassen North	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lassen South	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Pass	0	0	0	267	0	0	0	0	229	0	0	0	0	584	0	584
Mountain Pass	0	0	0	144	0	0	0	0	124	0	0	0	0	314	0	314
Mountain Pass subtotal	0	0	0	410	0	0	0	0	353	0	0	0	0	898	0	898
Needles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Owens Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Palm Springs	0	0	0	0	77	0	0	0	0	16	0	0	0	0	202	202
Pisgah-A	0	0	0	500	0	0	0	0	439	0	0	0	0	1,095	0	1,095
Riverside East	0	0	413	369	0	0	0	344	308	0	0	0	904	808	0	1,712
Riverside East	0	0	138	123	0	0	0	115	103	0	0	0	301	269	0	571
Riverside East subtotal	0	0	550	492	0	0	0	459	411	0	0	0	1,205	1,077	0	2,282
Round Mountain-A	0	67	0	0	0	0	60	0	0	0	0	445	0	0	0	445
Round Mountain-B	0	0	0	0	78	0	0	0	0	11	0	0	0	0	207	207
San Bernardino - Baker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Bernardino - Lucerne	0	0	0	0	42	0	0	0	0	6	0	0	0	0	110	110
San Diego North Central	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Diego South	0	0	0	0	118	0	0	0	0	18	0	0	0	0	319	319
Santa Barbara	0	0	0	0	83	0	0	0	0	6	0	0	0	0	216	216
Solano	0	0	0	0	38	0	0	0	0	13	0	0	0	0	100	100
Tehachapi	5	0	0	878	1,728	4	0	0	758	275	32	0	0	1,963	4,623	6,618
Tehachapi	2	0	0	376	740	2	0	0	325	118	14	0	0	841	1,981	2,836
Tehachapi subtotal	6	0	0	1,254	2,468	6	0	0	1,083	392	46	0	0	2,804	6,605	9,455
Twentynine Palms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Victorville	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Westlands	0	0	50	0	0	0	0	44	0	0	0	0	110	0	0	110
San Diego (Border substation)	21	0	0	0	0	19	0	0	0	0	92	0	0	0	0	92
Sylmar	10	0	0	0	0	9	0	0	0	0	44	0	0	0	0	44
Stockton	45	0	0	0	0	41	0	0	0	0	197	0	0	0	0	197
McFarland	44	0	0	0	0	40	0	0	0	0	193	0	0	0	0	193
Petaluma	5	0	0	0	0	5	0	0	0	0	22	0	0	0	0	22
Hanford	2	0	0	0	0	2	0	0	0	0	9	0	0	0	0	9
Blue Lake	11	0	0	0	0	10	0	0	0	0	48	0	0	0	0	48
Alberta	0	0	0	0	150	0	0	0	0	60	0	0	0	0	394	394
Alberta	0	0	0	0	300	0	0	0	0	121	0	0	0	0	788	788
Alberta	0	0	0	0	66	0	0	0	0	27	0	0	0	0	173	173
Alberta subtotal	0	0	0	0	516	0	0	0	0	208	0	0	0	0	1,356	1,356
Arizona			290			0	0	199	0	0			635			635
Arizona					418	0	0	0	0	149					1,319	1,319
Arizona			510	417	772	0	0	349	-15	274			1,319	1,319	2,639	5,277
Arizona			502	408		0	0	344	-15	0			1,319	1,319		2,638
Arizona subtotal	0	0	1,302	824	1,191	0	0	892	-31	423	0	0	3,273	2,638	3,958	9,869
Idaho	0	0	0	0	90	0	0	0	0	30	0	0	0	0	237	237
Montana	0	0	0	0	300	0	0	0	0	154	0	0	0	0	788	788
Nevada - South	0	0	1,051	1,281	386	0	0	737	-52	127	0	0	2,748	3,515	1,319	7,582
New Mexico	32					27	0	0	0	0	140					140
New Mexico					772	0	0	0	0	269					2,639	2,639
New Mexico subtotal	32	0	0	0	772	27	0	0	0	269	140	0	0	0	2,639	2,779
Oregon	0	0	0	0	614	0	0	0	0	207	0	0	0	0	1,614	1,614
Oregon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon subtotal	0	0	0	0	614	0	0	0	0	207	0	0	0	0	1,614	1,614
Wyoming	0	0	0	0	717	0	0	0	0	341	0	0	0	0	2,639	2,639
TOTAL	200	350	4,081	6,853	7,650	179	315	3,075	4,035	2,247	960	2,530	9,808	16,734	22,732	52,764

Table 4.6: Comparison of Renewable Generation Scenarios for CTPG Phase 1, RETI Phase 2A, CTPG Phase 2-Generation Queue and RETI Heavy In-State, CTPG Phase 3 RETI Best CREZ, and CTPG Phase 4 RETI West of River Stress Scenarios

	CTPG Phase 1 Scenaro		RETI Phase 2A Scenario*		CTPG Phase 2 Scenario				CTPG Phase 3 Portfolio		CTPG Phase 4 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)	RETI Phase 4 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	

	CTPG Phase 1 Scenaro		RETI Phase 2A Scenario*		CTPG Phase 2 Scenario				CTPG Phase 3 Portfolio		CTPG Phase 4 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)	RETI Phase 4 Annual Renewable Energy Production (GWh)
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	
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	

	CTPG Phase 1 Scenaro		RETI Phase 2A Scenario*		CTPG Phase 2 Scenario				CTPG Phase 3 Portfolio		CTPG Phase 4 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 Renewabl e Energy Productio n (GWh)**	**RETI Phase 3 Scenari o Installed Capacity (MW)**	**RETI Phase 3 Annual Renewable Energy Production (GWh)**	**RETI Phase 4 Annual Renewable Energy Production (GWh)**
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	
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 1.6 times the RETI net short.

4.4 Renewable Generation Production Profiles

As noted above in Phase 1 through Phase 3, 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.[7] In Phase 2, this information was updated by Black and Veatch to match the energy production profiles being used at that time by RETI. For study purposes, the CTPG utilizes the 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,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.

5 Generation Re-Dispatch

5.1 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 based on 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. In Phase 1 through Phase 3, the CTPG used several methods as the basis for reduction priority including using heat rate as a measure of the cost to generate and using fuel type as a measure for carbon production. In Phase 4, heat rates were used again to determine which units will be backed down first. Generally, a high heat rate translates into higher cost to produce electricity.

Some fossil generation, because of their location (i.e. must run or local capacity requirement), may be required for local reliability and may need to operate even though they would not otherwise be in economic merit-order. 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.

5.2 In State/Out of State

Phase 1 through Phase 3 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

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[7]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 .

with this assumption for both the heat rate and fuel type methods. Phase 3 utilized both the 70/30 constraint method and a fuel type method with no constraints on in-state/out-of-state. For Phase 4, CTPG has constrained the reverse economic merit-order back down by enforcing the 70/30 in-state/out-of-state back down constraint .

5.3 Re-Dispatch Method

The Heat Rate methodology decrements fossil generation in a reverse merit-order fashion (least economic reduced first). This merit order is 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 that are 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
Yucca CT2	1	19	14
WPhx GT1	1	56	14
WPhx GT2	1	56	14

External (Out of State)			
		Nameplate	
Reeves	1	40	13.613
	Total	**302 MW**	

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

BUS NO.	GENERATOR NAME	ID
SMUD		
37320	UCDMC	1
37321	COSUMNE1	1
37322	COSUMNE2	1
37323	COSUMNE3	1
37303	CAMPBEL1	1
37304	CAMPBEL2	1
37310	PROCTER1	1
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

6 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 through 4 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 4 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 scenarios as inputs, while CTPG is conducting the transmission modeling.

6.1 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 as an input for developing a ranking of the transmission elements included in the RETI Phase 2A transmission plan. However, the identification of the transmission elements included in the RETI Phase 2A transmission plan was based on the collective judgment of the RETI participants. In contrast, the CTPG is performing power flow and transient analysis that measures electric system performance under normal and contingency conditions and thereby provides an analytic basis for the transmission infrastructure additions identified in connection with each of the scenarios studied by CTPG. 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).[8] This results in a smaller set of transmission elements than identified by RETI.

6.2 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 through Phase 4, 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 megawatts of renewable capacity needed to achieve a 33% renewable energy target.

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

7 Identification of Additional High Commercial Interest CREZs

At the urging of stakeholders, in Phase 4, the CTPG wanted to determine if there are other CREZs located within the state or renewable resource development areas outside the state, that have similar high interest as those identified in Phase 3 and whether a revised renewable resource development pattern is in order, and if so, whether this pattern would result in potential reliability criteria violations and the identification of transmission infrastructure additions not previously identified by CTPG. Further, stakeholders want to know whether additional transmission upgrades should be added to the current listing of "high" and "medium" potential transmission upgrades.

The CTPG contacted Bonneville Power Administration (BPA), NV Energy (NVE), Arizona Public Service (APS), Salt River Project (SRP), New Mexico Public Service (PNM), the Western Area Power Administration – Desert Southwest Region (WAPA-DSW), and also received information from BC-Hydro, the Sierra Sub-regional Planning Group (SSPG) and the Southwest Area Transmission Planning Group (SWAT). The intent was to determine the relative status of the various interconnection requests in each party's generation interconnection queue and their respective transmission planning related to renewable energy delivery. The CTPG does not have access to relative PPA information associated with these proposed projects. The CTPG also reviewed publicly available information to determine the relative support provided at the state and federal level for the development of renewable energy resources in the western United States and the exporting of the energy to other states. The list of entities contacted was not intended to provide a complete inventory of activity in the west but rather an indication of what planning is underway, particularly adjacent to California. The CTPG understands that there are numerous other entities that are currently engaged in renewable energy planning and looks forward to exchanging information with these groups in the future.

7.1 Northern Scenario (Pacific Northwest and Northwest Nevada) Regions

As described above the CTPG surveyed BPA, NV Energy and the SSPG for information pertaining to renewable resource development in the Pacific Northwest and Northwest Nevada. In addition, the CTPG also received comments from BC Hydro.

BPA - In its comments to the CPUC on September 27, 2010[9] and on May 12, 2010 BPA[10], a Federal power marketing administration, stated that it markets approximately one-third of the electric power used in the Pacific Northwest and that it owns and operates approximately three-quarters of the high voltage transmission in the Pacific Northwest. In recent information provided by BPA to CTPG, BPA notes that it has interconnected approximately 3000 MW of wind generation with its system and that it expects to double its wind resources by 2013. Renewable energy installed capacity in BPA's BA is currently 30% of its peak load and is increasing by almost 10% per year. BPA has approximately twice as many megawatts of active generation requests in the interconnection queue as they have load. If all of this generation were to develop, Washington's and Oregon's RPS requirements of 15% by 2020 and 25% by 2025 respectively would be significantly exceeded.

In response to the request from CTPG, BPA chose to report a role-up of their queue status. To date they have approximately 11,000 MW of renewable resources that have interconnection studies underway. Approximately 9000

[9] Bonneville Power Administration, Bonneville Power Administration's Comments on Proposed Decision Modifying Decision 10-03-021 (Issued August 25, 2010) to the California Public Utilities Commission, September, 27, 2010.

[10] Bonneville Power Administration, Post-Workshop Reply Comments Of The Bonneville Power Administration to the California Public Utilities Commission, May 12, 2010

MW of renewable resource projects have interconnection studies completed. Of the 9000 MW, approximately 3000 MW are connected and 5,400 MW have executed interconnection agreements.

According to BPA, 47% of the contracts for renewable energy in their BA are with California Load Serving Entities. BPA is encouraging California to limit the use of unbundled RECs to meet the states RPS goals and believes there is need for new interregional transmission capacity. BPA also believes this is critical for the reliability of their electric system as well as impacts on endangered species associated with the hydro-electric facilities that are used to accommodate for the variability in wind generation. BPA is strongly encouraging California to assist in dealing with the resource variability[11]. According to BPA, they have come close to curtailing renewable energy resources under "low load/high hydro conditions." BPA and the Western Area Power Administration (WAPA) have the support of Congress[12] for funding the construction of new transmission infrastructure to collect and deliver renewable energy in the western United States.

It is important to note that a large percentage of existing imports from the Pacific Northwest into California are hydro-electric generated. This means that if there is not enough transfer capability to simultaneously accommodate desired imports of renewable energy and hydroelectric energy from the Pacific Northwest, it will be necessary to determine which resources are curtailed and the economic consequences of such curtailments could be significant no matter what choice is made. These economic consequences would be important considerations in determining whether the benefits of increasing transfer capability between the Pacific Northwest and California are likely to exceed the cost of such transfer capability.

BC Hydro - According to BC-Hydro the British Columbia Energy Act, passed by the British Columbia government, calls for BC-Hydro to be a net exporter of electricity from clean and renewable resources, achieve renewable resource self-sufficiency by 2016 including 3000 GWh of resource capability beyond their own needs by 2020, that their energy mix be 93% clean or renewable resources, and ensures that infrastructure will be built if market conditions warrant[13]. The BC-Hydro queue includes large amounts of wind and small hydro. BC-Hydro's existing system and projects currently in permitting or under construction allow for a reduction in hydro output during periods when variable wind resources are producing power and an increase in hydro output during periods when wind resources are not producing power. BC-Hydro believes that additional transmission capacity is needed between Canada and the United States. These transmission projects are under study in the WECC Regional Project Planning Process and the Pacific Northwest sub-regional planning groups. Based upon the projects completed and under construction, renewable resource developers in the BC Hydro area have successfully the permitted and financed, and constructed numerous projects.

NV Energy – NV Energy's 2009 peak load was approximately 7,100 MW. In its Portfolio Standard Annual Report Compliance Year 2009 to the Public Utilities Commission of Nevada[14], NV Energy reported successful additions of solar and geothermal resources in 2009 with the forecast of additional resources including wind in 2010. In its document titled "Nevada's Energy Economy Declaration,"[15] the Office of the Governor Nevada State Office of Energy is actively promoting an "Energy Economy" that would be founded on the development of renewable energy resources as well as the export of those resources. In the declaration, the Nevada State Office of Energy states "The

[11] BPA Wind/Thermal Displacement Plan Generates Pushback, California Energy Markets, December 10, 2010
[12] American Recovery and Reinvestment Act of 2009.
[13] Update On Generation and Transmission Status In British Columbia, BC Hydro, Ed Higgenbottom, May, 2010
[14] NV Energy Report on Compliance with the Portfolio Standard for Renewable Energy for Compliance year 2009, April 1, 2010
[15] Nevada's Energy Economy Declaration, Office of the Governor, Nevada State Office of Energy, March 22, 2010

renewable energy development opportunity will ultimately be driven by the energy export potential….Our ability to pipe electricity from the north, central and southern areas of the state is paramount in the capability to benefit from the huge CA market". The amount of resources, approximately 800 MW, with interconnection agreements is significant. The generation development queue for NV Energy contains enough renewable resources to far exceed Nevada's 25% RPS mandate for year 2025.

Table 7.1 summarizes the information received from NV Energy relative to the various renewable projects located in northwestern Nevada[16] and northeastern California[17] that were in the NV Energy/SPP queue as of September 29, 2010.

TABLE 7.1
NV ENERGY QUEUED PROJECTS IN NORTHWESTERN NEVADA AND NORTHEASTERN CALIFORNIA AS OF SEPTEMBER 29, 2010

Project Status		Resource Type			Totals
		Geo	Wind	Solar	
Projects With IA's	Number of Projects	16	2	0	18
	Total Capacity (MW)	551	262	0	813
Projects With Facility Studies	Number of Projects	2	1	0	3
	Total Capacity (MW)	75	150 [18]	0	225
Projects With Impact Studies	Number of Projects	3	7	1	11
	Total Capacity (MW)	106	920 [19]	20	1,046
Projects With Feasibility Studies	Number of Projects	4	1	1	6
	Total Capacity (MW)	232	120	50	402
Other Projects	Number of Projects	7	4	2	13
	Total Capacity (MW)	351	890 [20]	45	1,286
Subtotal	Number of Projects	14	12	4	30
	Total Capacity (MW)	689	1,930	115	2,734

As shown in Table 7.1, as of the end of September 2010, the NV Energy/SPP queue included:

- Sixteen geothermal projects and two wind projects (all in northwestern Nevada) with a combined capacity of about 810 MW which had interconnection agreements in place.
- Two geothermal projects (in northwestern Nevada) with a combined capacity of 75 MW and one, 150 MW wind project in Lassen County which had completed their Facility Studies.

16 Includes Washoe, Humboldt, Pershing, Churchill, Lander, Lyon, Mineral, Nye, and Esmeralda Counties
17 Lassen County
18 Project is in Lassen County. In 2011, the Sierra Sub-regional Transmission Planning Group will be analyzing several proposed transmission projects from northwest Nevada to California. These projects are intended to deliver renewable resources from northwest Nevada and northeast California to the California load centers.
19 Two of these projects with a total capacity of 260 MW are in Lassen County
20 Two of these projects with a total capacity of 350 MW are in Lassen County

- Fourteen other proposed geothermal projects (all in Northwestern Nevada) with a total capacity of approximately 690 MW. Of this capacity:
  - System Impact Studies had been completed for approximately 110 MW (15%),
  - Feasibility Studies had been completed for approximately 230 MW (34%),and
  - Approximately 350 MW (51%) was under study but had not yet completed their Feasibility Studies.
- Twelve other proposed wind projects with a total capacity of 1,930 MW. Of this capacity:
  - System Impact Studies had been completed for 920 MW (48%); 260 MW of this capacity would be located in Lassen County,
  - Feasibility Studies had been completed for 120 MW (6%), and
  - 890 MW (46%) was under study but had not yet completed their Feasibility Studies; 350 MW of this capacity would be located in Lassen County.

7.2 Southwest Region

The CTPG surveyed NV Energy, APS, SRP, WAPA-DSW, PNM, and SWAT for information pertaining to renewable resource development in the Southwest. In addition, the CTPG gathered other publicly available information that would help in determining the status of renewable resource development in the desert southwest region.

The CTPG Phase 4 studies considered the importing of renewable energy into California from the Southwest Region at three points of entry. They are the El Dorado Valley located in southern Nevada, Palo Verde located and North Gila both located in Arizona. The El Dorado Valley is generally considered the destination for renewable energy from generator locations in southern Nevada, Utah, Wyoming, and Montana. Palo Verde and North Gila are considered the destination for renewable energy from generators in Arizona, New Mexico, and other points south. In addition, the Southwest Region includes the Western Area Power Administration-Desert Southwest Region which includes parts of southern California. The following is a limited characterization of status of renewable energy development policy in Wyoming, Utah, Arizona, Nevada, and New Mexico.

Wyoming – The state of Wyoming does not currently have a RPS. However, the state ranks 5th in the west for wind generation and is recognized for its wind generation potential[21]. The state has established the Wyoming Infrastructure Authority which is responsible for "overseeing and encouraging" the development of new transmission facilities for interconnecting renewable energy generators to markets located at this time primarily out of state. At this time, renewable energy development is primarily driven by interests outside of the state.

Utah - The State of Utah has a RPS of 20% by 2025 for IOU and POU load serving entities. The state of Utah has created the Utah Renewable Energy Zone (UREZ) Task Force that is responsible for identifying renewable energy zones, support renewable energy development, and identify necessary transmission to bring resources to market. The UREZ Task Force Phase II report[22] identified and analyzed the need to deliver renewable resource energy out of

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[21] *Renewable Energy Policy, State of Wyoming-2010,* Climate Control Ltd, 2010, Nick Baker

[22] Utah Renewable Energy Zone (UREZ) Task Force, Phase II, Zone Identification and Scenario Analysis, Final Report. Black and Veatch Corporation, September 10, 2010.

state. In the Phase II report the UREZ Task Force developed a "Conceptual Transmission Map" for collecting energy from identified high potential zones for deliver to location at the state border.

Arizona – The State of Arizona has a RPS of 15% by 2025 for regulated load serving entities. The state of Arizona's Department of Commerce has completed the "Arizona Solar Electric Roadmap Study"[23] The roadmap describes the recommended actions for the state to move forward with the development of solar resources as an "economy defining" opportunity. According to the Arizona State University, W.P. Carey School of Business, "Arizona stands to benefit more than any other state by producing and exporting solar energy." This is primarily due to its quality of solar radiation and the small electric demand, The Greater Phoenix Economic Council (GPEC) which is a public and private partnership of 18 cities and towns in the Greater Phoenix area, the county of Maricopa, and approximately 150 Arizona companies has been formed to encourage the diversifying of the solar industry with the state including the export of renewable energy to California and other western states.

Nevada - In its Portfolio Standard Annual Report Compliance Year 2009 to the Public Utilities Commission of Nevada[24], NV Energy reported successful additions of solar and geothermal resources in 2009 with the forecast of additional resources including wind in 2010. In its document titled "Nevada's Energy Economy Declaration,"[25] the Office of the Governor Nevada State Office of Energy is actively promoting an "Energy Economy" that would be founded on the development of renewable energy resources as well as the export of those resources. In the declaration, the Nevada State Office of Energy states "The renewable energy development opportunity will ultimately be driven by the energy export potential….Our ability to pipe electricity from the north, central and southern areas of the state is paramount in the capability to benefit from the huge CA market". The amount of resources, approximately 800 MW, with interconnection agreements is significant. The generation development queue for NV Energy contains enough renewable resources to far exceed Nevada's 25% RPS mandate for year 2025.

NV Energy – NV Energy's 2009 peak load was approximately 7,100 MW. Table 7.2 summarizes the information received from NV Energy relative to the various renewable projects located in southern Nevada that were in the NV Energy queue as of September 29, 2010.

TABLE 7.2
NV ENERGY QUEUED PROJECTS IN SOUTHERN NEVADA AS OF SEPTEMBER 29, 2010

Project Status		Resource Type			Totals
		Geo	Wind	Solar	
Projects With IA's	Number of Projects	0	0	1	1
	Total Capacity (MW)	0	0	64	64
Projects With Facility Studies	Number of Projects	0	0	5	5
	Total Capacity (MW)	0	0	1,059	1,059
Projects With Impact Studies	Number of Projects	0	0	7	7
	Total Capacity (MW)	0	0	304	304

[23] Arizona Solar Electric Roadmap Study, Arizona Department of Commerce, prepared by Navigant Consulting, January, 2007.
[24] NV Energy Report on Compliance with the Portfolio Standard for Renewable Energy for Compliance year 2009, April 1, 2010
[25] Nevada's Energy Economy Declaration, Office of the Governor, Nevada State Office of Energy, March 22, 2010

Projects With Feasibility Studies	Number of Projects	0	0	7	7
	Total Capacity (MW)	0	0	551	551
Other Projects	Number of Projects	0	2	9	11
	Total Capacity (MW)	0	700	617	1,317
Subtotal	Number of Projects	0	2	23	25
	Total Capacity (MW)	0	700	1,472	2,172

As shown in Table 7.2, as of the end of September 2010, the NV Energy queue for southern Nevada included:

- A single 64 MW solar project which had an interconnection agreement in place.
- Five solar projects with a combined capacity of 1,059 MW which had completed their Facility Studies.
- Twenty-three other proposed solar projects with a total capacity of approximately 1,470 MW. Of this capacity:
  - System Impact Studies had been completed for approximately 300 MW (21%),
  - Feasibility Studies had been completed for approximately 550 MW (37%),and
  - Approximately 620 MW (42%) was under study but had not yet completed their Feasibility Studies.
- Two proposed wind projects with a total capacity of 700 MW for which the Feasibility Studies had not yet been completed.

The information provided for northern Nevada described above for the northwest Nevada region is also true for the southern Nevada region.

***APS* –** APS's 2009 peak load was approximately 8,000 MW. Table 7.3 summarizes the information on proposed renewable projects that were in the APS queue as of September 1, 2010.

TABLE 7.3
APS QUEUED PROJECTS AS OF SEPTEMBER 1, 2010

Project Status		Resource Type		Totals
		Wind	Solar	
Projects With IA's	Number of Projects	1	1	2
	Total Capacity (MW)	128	500	628
Projects With Studies Available	Number of Projects	6	24	30
	Total Capacity (MW)	2,335	5,566	7,901
Projects Without Studies Available	Number of Projects	7	63	70
	Total Capacity (MW)	1,129	1,459	2,588

As shown in Table X1, as of the first of September 2010, the APS queue included:

- Two projects (one solar and one wind) with a combined capacity of approximately 630 MW which had interconnection agreements in place.
- Thirteen other wind projects with a combined capacity of approximately 3,460 MW. Of this capacity:
  - Study reports were available for six of these projects which have a combined capacity of approximately 2,340 MW (68%),
  - Study reports were not available for the remaining seven projects which have a combined capacity of approximately 1,130 MW (32%),
- Eighty-seven other solar projects with a combined capacity of approximately 7,030 MW. Of this capacity:

- Study reports were available for twenty-four of these projects which have a combined capacity of approximately 5,570 MW (79%),
- Study reports were not available for the remaining sixty-three projects which have a combined capacity of approximately 1,460 MW (21%). It is noted a majority of these projects are sized at 20 MW or less.

SRP – SRP's 2009 peak load was approximately 6,400 MW. Table X2 summarizes the information on proposed renewable projects that were in the SRP queue as of September 14, 2010.

TABLE X2
SRP QUEUED PROJECTS AS OF SEPTEMBER 14, 2010

Project Status		Resource Type		Totals
		Wind	Solar	
Projects With IA's	Number of Projects	0	0	0
	Total Capacity (MW)	0	0	0
Projects With Studies Available	Number of Projects	2	7	9
	Total Capacity (MW)	900	1,470	2,370
Projects Without Studies Available	Number of Projects	2	7	9
	Total Capacity (MW)	300	725	1,025

As shown in Table X2, as of the middle of September 2010, the SRP queue:

- Did not include any projects for which had interconnection agreements had been executed.
- Included four wind projects with a combined capacity of approximately 1,200 MW. Of this capacity:
  - Study reports were available for two of these projects which have a combined capacity of 900 MW (75%),
  - Study reports were not available for the remaining two projects which have a combined capacity of 300 MW (25%),
- Included fourteen solar projects with a combined capacity of approximately 2,200 MW. Of this capacity:
  - Study reports were available for seven of these projects which have a combined capacity of 1,470 MW (67%),
  - Study reports were not available for the remaining seven projects which have a combined capacity of approximately 730 MW (33%).

WAPA-DSW **-** The Western Area Power Administration, Desert Southwest Region sells power in Arizona, southern California, and wholesale customers in portions of the Southwest. WAPA-DSW has the support of Congress[26] for funding the construction of new transmission infrastructure to collect and deliver renewable energy in the western United States.

Table X3 summarizes the information on proposed renewable projects that were in the WAPA-DSW queue as of September 13, 2010.

TABLE X3
WAPA-DSW QUEUED PROJECTS AS OF SEPTEMBER 13, 2010

	Resource Type	Totals

[26] American Recovery and Reinvestment Act of 2009.

	Geotherm.	Wind	Solar	
Number of Projects	1	6	8	15
Total Capacity (MW)	250	2,115	2,465	4,830

The WAPA-DSW queue does not provide information as to which of the various studies (Feasibility, System Impact, Facility) have been completed on the projects listed in the queue. As shown in Table X3, as of the middle of September 2010, the WAPA-DSW queue included:

- One geothermal project with a capacity of 250 MW.
- Six wind projects with a combined capacity of approximately 2,120 MW.
- Eight solar projects with a combined capacity of approximately 2,470 MW.

PNM - The state of New Mexico has an RPS goal of 20% by 2020. PNM's 2009 peak load was approximately 1,900 MW. PNM has developed a conceptual transmission plan[27] for collecting wind resources throughout New Mexico for delivery to load centers within the state as well as delivery to out-of-state markets. Table X4 summarizes the information contained within the PNM LGIP queue as of August 31, 2010. As shown in Table X4, as of the end of August 2010, the PNM LGIP queue included:

- Ten wind projects with a combined capacity of approximately 1,770 MW which had interconnection agreements in place or under negotiation.
- Two wind projects with a combined capacity of 250 MW for which Facility Studies had been completed or were underway.
- Twenty-eight other proposed wind projects with a total capacity of approximately 12,620 MW. Of this capacity:
  - o System Impact Studies had been completed or were underway for twenty projects with a combined capacity of approximately 5,530 MW (44%), and
  - o Feasibility Studies had been completed or were underway for eight projects with a combined capacity of approximately 7,090 MW (56%).
- Twelve proposed solar projects with a total capacity of approximately 1,300 MW. Of this capacity:
  - o System Impact Studies had been completed or were underway for five projects with a combined capacity of approximately 300 MW (23%), and
  - o Feasibility Studies had been completed or were underway for twelve projects with a combined capacity of approximately 1,000 MW (77%).

TABLE X4
PNM QUEUED PROJECTS AS OF AUGUST 31, 2010

Project Status		Resource Type		Totals
		Wind	Solar	
Projects With IA's	Number of Projects	10	0	10
	Total Capacity (MW)	1,771	0	1,771
Projects With Facility Studies	Number of Projects	2	0	2
	Total Capacity (MW)	250	0	250
Projects With Impact Studies	Number of Projects	20	5	25
	Total Capacity (MW)	5,530	295	5,825

[27] New Mexico Transmission Expansion Concepts For Wind Resources, PNM, May, 2009

Projects With Feasibility Studies	Number of Projects	8	7	15
	Total Capacity (MW)	7,091	998	8,089
Subtotal	Number of Projects	28	12	40
	Total Capacity (MW)	12,621	1,293	13,914

8 Scenario Analysis and Case Results

8.1 RETI West of River Stress Scenario – Southern California Peak (WOR_B2SW)

8.1.1 Case Description

This case was started from the 2019 WECC heavy summer power flow case and modified to model 2020 summer peak load forecast for 1-in-10 year adverse weather conditions in Southern California. Renewable "net-short" resources added to the resultant case to achieve California's 33% percent renewable portfolio standard were based on those outlined in the "RETI West of River Stress Scenario" and are summarized by technology and location in Table 2.

8.1.2 Case Objective

The objective of the RETI West of River Stress Scenario base case is to identify transmission upgrades that will mitigate reliability criteria violations that may arise as a result of the RETI West of River Stress Scenario renewable resource additions under Southern California peak load conditions.

8.1.3 Grid Configuration

Table 1 lists major path flows both before and after the addition of the renewable generation. Table 2 summarizes the energy contribution from renewable resources by technology and location that would meet the projected year 2020 renewable net short.

Several grid configuration changes were made to the 2019 WECC "heavy summer" power flow case to connect the RETI West of River Stress Scenario renewable resource additions to the grid and to add network transmission facilities required to obtain a power flow solution. Table 3 lists the grid configuration changes.

Table 1: Major Inter-tie Flows

Path Name	Current Rating (MW)	Flow in Seed Case (MW)	Flow in Phase IV B2_WOR Case (MW)
COI	4800	3341	3735
Path 15	3265 (N-S) 5400 (S-N)	1011 (S-N)	1,344 (S-N)
Path26	4000 (N-S) 3000 (S-N)	2,281 (N-S)	1,893 (N-S)

EOR	9300	4,569	5,526
WOR	10623	7,130	9,799

With respect to the information in Table 1 it is noted that the modeled WOR flows in the B1 (Seed Case) are very close to 7,250 MW (which was the maximum flow measured over the Path) during the summer of 2010

Table 2: Energy contribution from renewable resources by technology and location to meet the net short

	Installed	Dispatched	Energy (GWh)
Resources by Technology			
Wind	7,650	2,406	22,732
PV	4,081	2,834	9,808
Bio	200	179	960
Solar Th.	6,853	5,107	16,734
Geo	350	315	2,530
Total	19,134	10,841	52,764
Resources by Location			
California	10,057	6,895	25,901
"WOR Hubs" [28]	7,525	3,667	22,728
Other OOS	1,552	279	4,135
Total	19,134	10,841	52,764

Table 3: CREZ installed capacity and network connection

CREZ/Renewable Development Area			
Location	CTPG – Identified Renewable Resource Addition: Installed Capacity (MW)	Grid Configuration Changes	Reason for Adding

[28] Renewable power injections modeled at Eldorado, Palo Verde, and North Gila 500-kV busses.

Fairmont	692	Build new Fairmont 500 kV substation looping-in existing 500 kV Adelanto-Rinaldi2 #1 and existing 500 kV Victorville-Rinaldi #1 line.	Interconnect generators
Imperial North-A	239	Upgrade existing Coachella – Mirage 230 kV line Build new Hudson Tap 230 kV substation Build two new Midway – Hudson Tap 230 kV lines Build new Bannister 230 kV substation Build two new Hudson Tap-Bannister 230 kV lines Build new El Centro to Bannister 230 kV line	Interconnect generators, and mitigate normal and contingency overloads
Imperial South	389	Build new IIDIV 230 kV substation Existing IV-EL Centro 230 kV line loops-in into IIDIV Build new IV-IIDIV-EL Centro 230 kV line Build new Sunrise Power link (New Imperial Valley - Central 500kV line and associated upgrades) Add new Imperial Valley 500/230 kV bank #3	Interconnect generators, and mitigate normal and emergency overloads
Iron Mountain	150	None	
Mountain Pass	267	Build new IVANPAH 230/115kV substation looping in existing 115kV Coolwater-Dunn Siding–Baker-Mountain Pass-Eldorado line	Interconnect generators,
Mountain Pass	144	Build new Primm 230kV substation (just into western Nevada along I-15)	Interconnect generators,
Palm Springs	77	None	
Pisgah-A	500	Build new Pisgah 500 kV substation looping in existing 500 kV Eldorado-Lugo #1 line creating a 500 kV Eldorado-Pisgah #1 line and a 500 kV Pisgah-Lugo #1 line; Remove existing Pisgah – Lugo #2 230 line; Build new Pisgah – Lugo #2 500 kV line.	Interconnect generators, and mitigate normal and emergency overloads
Riverside East	1042	Build new Colorado River 500 kV substation (two transformers) Build new Red Bluff 500 kV substation (one transformer)	Interconnect generators, mitigate normal and emergency overloads, and mitigate voltage

		Existing Palo Verde – Devers 500 kV #1 line loops-in into Colorado River and Red Bluff Build new Colorado River- Red Bluff – Devers #2 500 kV line Build new Devers – Valley 500 kV line	and transient instability
San Bernardino - Lucerne	42	None	*Interconnect generators at Lugo 230kV*
Kramer	1,367	Build new Kramer 500kV substation (upgrade from the existing 230kV substation) Add two Kramer 500/230kV transformers Build new LLANO 500kV switching station Lugo - Vincent #2 500kV line looped into LLANO 500kV switching station Build new Kramer - LLANO 500kV line	Interconnect generators, and mitigate normal and emergency overloads
Round Mt - A	67	Build new 230 kV renewable station; Loop PIT 3-Round Mountain 230 kV into a new renewable substation	Interconnect generators
Round Mt - B	78	None	
San Diego south	118	Build new Wind Farm 500 kV substation; Imperial Valley – Miguel 500 kV line loops-in into Wind Farm	Interconnect generators, and mitigate normal and emergency overloads emergency overloads
Santa Barbara	83	None	
Solano	38	None	
Tehachapi	3,728	All segments of TRTP A second and a third Whirlwind 500/230 kV 1120N/1230E MVA transformers The third Barren Ridge – Haskell Canyon 230 kV line	TRTP project Mitigate normal overload 9. Deliver the new generation connecting at Barren Ridge
Carrizo South	849	Build two new 230kV substation looping in existing Morro Bay-	Interconnect

		Midway #1 and #2 230kV lines Reconductoring Morro Bay – Midway 230 kV #1 and #2 lines	generators; Mitigate normal and contingency overload
Westlands	50	None	Model at Westlands 115 kV substation
San Diego	21	None	*Interconnected at Border substation*
Sylmar	10		Model at Sylmar 230 kV substation
Stockton	45		Model at Stagg 230 kV bus
McFarland	44		Model at Semitropic 115 kV bus
Petaluma	5		Model at Lakeville 230 kV
Hanford	2		Model at Henrietta 115 kV bus
Blue Lake	11		Model at Fairhaven 60 kV bus

8.1.4 Results

CTPG's analysis found a number of reliability criteria violations under the assumed system conditions that were studied. The contingency basis of those violations, and possible mitigation for some of those violations, is shown in Appendix 1. Table 4 lists the bulk transmission facilities (generally 230 kV and above) on which thermal overloads were identified. Transmission infrastructure additions that would mitigate some of those thermal overloads are also summarized in Table 4. CTPG has not explored a full range of wires and non-wires alternatives for mitigating identified reliability criteria violations and invites stakeholders to propose such alternatives.

Table 4: Bulk transmission facilities for which thermal overloads were identified.

Power Flow Study Area	Bulk Transmission Facility	Possible Mitigation

LADWP	LUGO-VICTORVL #1 500KV LINE	Upgrade terminal equipment at Victorville and raise towers [29]
PG&E	BORDEN-GREGG #1 230KV LINE	Rebuild the 230kV line with higher capacity
SCE	KRAMER-LUGO #1 and #2 230KV LINES	Revise SPS of tripping North of Lugo generation
SCE	PISGAH -LUGO #1 230KV LINE	Loop in 500KV Mojave-Lugo line at Pisgah
SCE	BARRE - LEWIS #1 230KV LINE	Upgrade the rating, dispatch local generators, or build new transmission line into Western LA Basin.
SCE	BARRE - ELLIS #1 230KV LINE	Reconductor, upgrade the rating, dispatch local generators, or build new transmission line into Western LA Basin.
SCE	SANBRDNO-DEVERS #1 230KV LINE	West of Devers upgrades
SCE	DEVERS-EL CASCO #1 230KV LINE	West of Devers upgrades
SCE	LEWIS -VILLA PK #1 230KV LINE	Reconductor, upgrade the rating, dispatch local generation, or build new line into western LA Basin
SCE	LEWIS -SERRANO #2 230KV LINE	Upgrade the rating, dispatch local generation, or build new line into western LA Basin.
SDG&E	IMPRLVLY-N.GILA #1 500KV LINE	Upgrade 500kV series capacitor on the IMPRLVLY -N.GILA 500KV line and/or Contingency SPS bypass of the series capacitor.
SDG&E	Central 500/230Kv Transformers #1 and #2	Third 500/230 Transformer Bank at Central Substation
SDG&E	Miguel 500/230Kv Transformers #1 and #2	SPS (transfer trip IV gen and Contingency SPS bypass of the series capacitor on the IMPRLVLY -N.GILA 500KV line)
SDG&E	IMPRLVLY - ROA-230 #1 230 KV Line,	SPS (Transfer trip IV gen and IV-ROA230 or Otay Mesa-TJI 230kV lines)
SDG&E	SYCAMORE 230/138KV #1 TRANSFORMER	Build Sycamore-Penasquitos 230kV line
SDG&E	ESCNDIDO - TALEGA #1 230 KV Line,	SPS (controlled load drop)

8.2 RETI West of River Stress Scenario – Autumn Off-Peak (WOR_F2-6700)

8.2.1 Case Description

This case was developed from the Autumn Sensitivity Case (Case F0) which, as discussed in the CTPG Phase 3 report, was based on the 2019 WECC heavy summer power flow case and was modified to model 2020 light autumn (September morning at 9 AM) loads and Path 15 and Path 26 flows of approximately 5,030 MW and 2,170 MW in the south-to-north direction, respectively. West-of-River (WOR) flows in the resultant case were at approximately 10,090 MW in the east-to-west direction. The case was modified by re-dispatching resources outside of California such that

[29] Other potential "upgrade" options to mitigate overloads on this line have been identified by LADWP and include adjusting the series compensation in parallel 500-kV lines or building a second Victorville-Lugo line.

the flow on the West-of-River path was 6,700 MW which is equal to the historical peak flows on the path during the 9 AM hour in September 2010. Renewable "net short" resources added in the "WOR_F2-6700" case to achieve California's 33 percent renewable portfolio standard were based on those outlined in the "RETI West of River Stress Scenario" and are summarized by technology and location in Table 2.

8.2.2 Case Objective

The objective of this RETI West of River Stress Scenario base case is to identify transmission upgrades that will mitigate reliability criteria violations that may arise as a result of the RETI West of River Stress Scenario renewable resource additions with approximately historical east-to-west peak flows for the given time of day and month on the WOR Path.

8.2.3 Grid Configuration

Table 1 lists major path flows both before and after the addition of the renewable generation. Table 2 summarizes the energy contribution from renewable resources by technology and location that would meet the projected year 2020 renewable net short.

Several grid configuration changes were made to the 2019 WECC "heavy summer" power flow case to connect the RETI West of River Stress Scenario renewable resource additions to the grid and to add network transmission facilities required to obtain a power flow solution. Table 3 lists the grid configuration changes.

Table 1: Major Inter-tie Flows

Path Name	Existing Rating (MW)	Flow in F0 Case (MW)	Flow in F2 Case (MW)
COI	4800 (N-S) 3675 (S-N)	865 (N-S)	572 (N-S)
Path 15	3265 (N-S) 5400 (S-N)	598 (S-N)	2,328 (S-N)
Path26	4000 (N-S) 3000 (S-N)	1,355 (N-S)	89 (N-S)
EOR	9300	4812	4,607
WOR	10623	6,700	8,963
PDCI	3100	962 (S-N)	962 (S-N)
IPP DC	2400	1,738	1,738

Table 2: Energy contribution from renewable resources by type and location to meet the net short

	Installed	Dispatched	Energy (GWh)
Resources by Technology			
Wind	7,650	2,247	22,732
PV	4,081	3,075	9,808
Bio	200	179	960
Solar Th.	6,853	4,035	16,734
Geo	350	315	2,530
Total	19,134	9,851	52,764
Resources by Location			
California	10,057	6,518	25,901
"WOR Hubs" [30]	7,525	2,706	22,728
Other OOS	1,552	627	4,135
Total	19,134	9,851	52,764

Table 3: CREZ installed capacity and network connection

Location	CTPG – Identified Renewable Resource Addition: Installed Capacity (MW)	Grid Configuration Changes	Reason for Adding
CREZ Areas			
Fairmont	692	none	
Imperial North-A	239	Build new Geo ("Hudsontap") 230kV substation (connect to Midway 230kV substation)	Interconnect generators
Imperial South	389	None	

[30] Renewable power injections modeled at Eldorado, Palo Verde, and North Gila 500-kV busses and generation interconnected at a tap on Hassayampa-North Gila 500-kV line

Iron Mountain	150	None	
Mountain Pass	267	Build new Ivanpah 230/115kV substation looping in existing 115kV Coolwater-Dunn Siding–Baker-Mountain Pass-Eldorado line	Interconnect generators
Mountain Pass	144	Build new Primm 230kV substation (just into western Nevada along I-15)	Interconnect generators
Palm Springs	77	None	
Pisgah-A	500	Build new Pisgah 500 kV substation looping in existing 500 kV Eldorado-Lugo #1 line creating a 500 kV Eldorado-Pisgah #1 line and a 500 kV Pisgah-Lugo #1 line.	Interconnect generators and mitigate normal and emergency overloads
Riverside East	781	Build new Colorado River 500 kV substation looping-in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Palo Verde-Colorado River #1 line and a 500 kV Colorado River-Red Bluff #1 line. Add two 500/230 kV transformers	Interconnect generators, and mitigate normal and emergency overloads
Riverside East	260	Build new Red Bluff 500 kV substation looping in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Colorado River-Red Bluff #1 line. Add one 500/230 kV transformer.	Interconnect generators and mitigate normal and emergency overloads
San Bernardino - Lucerne	42	Build new Lucerne 230 kV substation in the San Bernardino-Lucerne CREZ (connect to grid with a 230 kV Lucerne-Lugo #1 line.)	Interconnect generators
Kramer	1,367	1. New Kramer 500kV substation (upgrade from the existing 230kV substation 2. Two Kramer 500/230kV transformers 3. New Llano 500kV switching station 4. Lugo – Vincent #1 and #2 500kV lines looped into Llano 500kV switching station 5. New Kramer - Llano 500kV line	Interconnect generators and mitigate normal and emergency overloads
Round Mt - A	67	None	
Round Mt - B	78	None	
San Diego south	118	Sunrise Power link (New Imperial Valley - Central 500kV line and associated upgrades)	Mitigate emergency overloads

Solano	38	None	
Tehachapi	3,728	All segments of TRTP	TRTP project
Westlands	50	None	
Carrizo South	849	Build new Carrizo 230kV substation looping in existing Morro Bay-Midway #1 and #2 230kV lines	Interconnect generators
Santa Barbara	83	None	
N/A	N/A	New Gregg 500kV substation with two 500/230kV transformer banks and new Midway-Gregg 500kV DCTL	Mitigate normal and contingency overloads on Path 15 lines
Other Areas			
Westlands	50	None	Model at Westlands 115-kV substation
San Diego	21	None	Interconnected at Border substation
Sylmar	10	None	Model at Sylmar 230 kV substation
Stockton	45	None	Model at Stagg 230 kV bus
McFarland	44	None	Model at Semitropic 115 kV bus
Petaluma	5	None	Model at Lakeville 230 kV
Hanford	2	None	Model at Henrietta 115 kV bus

8.2.4 Results

CTPG's analysis found a number of reliability criteria violations under the assumed system conditions that were studied. The contingency basis of those violations, and possible mitigation for some of those violations, is shown in Appendix 1. Table 4 lists the bulk transmission facilities (generally 230 kV and above) on which thermal overloads were identified. Transmission infrastructure additions that would mitigate some of those thermal overloads are also summarized in Table 4. CTPG has not explored a full range of wires and non-wires alternatives for mitigating identified reliability criteria violations and invites stakeholders to propose such alternatives.

Table 4: Bulk transmission facilities for which thermal overloads were identified.

Area	Bulk Transmission Facility	Possible Mitigation
IID	Coachella Valley-Ramon 230 kV	Path 42 Upgrade
IID	Coachella Valley-Mirage 230 kV	Path 42 Upgrade
IID	Ramon-Mirage 230 kV	Path 42 Upgrade
SCE	Devers-San Bernardino 230 kV	West of Devers 230 kV Upgrades
SCE	Devers-El Casco 230 kV	West of Devers 230 kV Upgrades
SCE	Pisgah-Lugo 230 kV #1	Loop Lugo-Mohave 500 kV into Pisgah 500 kV
LADWP	Fairmont-Rinaldi 500 kV #1	Upgrade Terminal Equipment
LADWP	Fairmont-Rinaldi 2 500 kV #1	Upgrade Terminal Equipment

8.3 RETI West of River Stress Scenario – Autumn Off-Peak (WOR_F2)

8.3.1 Case Description

This case was developed from the Autumn Sensitivity Case (Case F0) which, as discussed in the CTPG Phase 3 report, was based on the 2019 WECC heavy summer power flow case and was modified to model 2020 light autumn (September morning at 9 AM) loads and Path 15 and Path 26 flows of approximately 5,030 MW and 2,170 MW in the south-to-north direction, respectively. West-of-River (WOR) flows in the resultant case were at approximately 10,090 MW in the east-to-west direction. Renewable "net short" resources added in the "WOR_F2" case to achieve California's 33 percent renewable portfolio standard were based on those outlined in the "RETI West of River Stress Scenario" and are summarized by technology and location in Table 2.

8.3.2 Case Objective

The objective of this RETI West of River Stress Scenario base case is to identify transmission upgrades that will mitigate reliability criteria violations that may arise as a result of the RETI West of River Stress Scenario renewable resource additions with heavy east-to-west flows on the WOR Path and heavy south-to-north flows on Path 15 and Path 26.

8.3.3 Grid Configuration

Table 1 lists major path flows both before and after the addition of the renewable generation. Table 2 summarizes the energy contribution from renewable resources by technology and location that would meet the projected year 2020 renewable net short.

Several grid configuration changes were made to the 2019 WECC “heavy summer” power flow case to connect the RETI West of River Stress Scenario renewable resource additions to the grid and to add network transmission facilities required to obtain a power flow solution. Table 3 lists the grid configuration changes.

Table 1: Major Inter-tie Flows

Path Name	Existing Rating (MW)	Flow in F0 Case (MW)	Flow in F2 Case (MW)
COI	4800 (N-S) 3675)S-N)	2,661 (S-N)	2,534 (S-N)
Path 15	3265 (N-S) 5400 (S-N)	5,032 (S-N)	5,495 (S-N)
Path26	4000 (N-S) 3000 (S-N)	2,164 (S-N)	3,164 (S-N)
EOR	9300	7,768	7,339
WOR	10623	10,085	11,927
PDCI	3100	962 (S-N)	962 (S-N)
IPP DC	2400	1,738	1,738

With respect to the information in Table 1 it is noted that the modeled WOR flows are considerably higher than recent historical flows. For example, during September 2010 the maximum WOR flows during the 9 AM hour were approximately 6,600 MW while the average flows during this hour were approximately 5,800 MW.

Table 2: Energy contribution from renewable resources by type and location to meet the net short

	Installed	Dispatched	Energy (GWh)
Resources by Technology			
Wind	7,650	2,247	22,732
PV	4,081	3,075	9,808
Bio	200	179	960
Solar Th.	6,853	4,035	16,734
Geo	350	315	2,530

Total	19,134	9,851	52,764
Resources by Location			
California	10,057	6,518	25,901
"WOR Hubs" [31]	7,525	2,706	22,728
Other OOS	1,552	627	4,135
Total	19,134	9,851	52,764

Table 3: CREZ installed capacity and network connection

Location	CTPG – Identified Renewable Resource Addition: Installed Capacity (MW)	Grid Configuration Changes	Reason for Adding
CREZ Areas			
Fairmont	692	none	
Imperial North-A	239	Build new Geo ("Hudsontap") 230kV substation (connect to Midway 230kV substation)	Interconnect generators
Imperial South	389	None	
Iron Mountain	150	None	
Mountain Pass	267	Build new Ivanpah 230/115kV substation looping in existing 115kV Coolwater-Dunn Siding–Baker-Mountain Pass-Eldorado line	Interconnect generators
Mountain Pass	144	Build new Primm 230kV substation (just into western Nevada along I-15)	Interconnect generators
Palm Springs	77	None	
Pisgah-A	500	Build new Pisgah 500 kV substation looping in existing 500 kV Eldorado-Lugo #1 line creating a 500 kV Eldorado-Pisgah #1 line and a 500 kV Pisgah-Lugo #1 line.	Interconnect generators and mitigate normal and emergency overloads

[31] Renewable power injections modeled at Eldorado, Palo Verde, and North Gila 500-kV busses and generation interconnected at a tap on Hassayampa-North Gila 500-kV line

Riverside East	781	Build new Colorado River 500 kV substation looping-in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Palo Verde-Colorado River #1 line and a 500 kV Colorado River-Red Bluff #1 line. Add two 500/230 kV transformers	Interconnect generators, and mitigate normal and emergency overloads
Riverside East	260	Build new Red Bluff 500 kV substation looping in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Colorado River-Red Bluff #1 line. Add one 500/230 kV transformer.	Interconnect generators and mitigate normal and emergency overloads
San Bernardino - Lucerne	42	Build new Lucerne 230 kV substation in the San Bernardino-Lucerne CREZ (connect to grid with a 230 kV Lucerne-Lugo #1 line.)	Interconnect generators
Kramer	1,367	1. New Kramer 500kV substation (upgrade from the existing 230kV substation 2. Two Kramer 500/230kV transformers 3. New Llano 500kV switching station 4. Lugo – Vincent #1 and #2 500kV lines looped into Llano 500kV switching station 5. New Kramer - Llano 500kV line	Interconnect generators and mitigate normal and emergency overloads
Round Mt - A	67	None	
Round Mt - B	78	None	
San Diego south	118	Sunrise Power link (New Imperial Valley - Central 500kV line and associated upgrades)	Mitigate emergency overloads
Solano	38	None	
Tehachapi	3,728	All segments of TRTP	TRTP project
Westlands	50	None	
Carrizo South	849	Build new Carrizo 230kV substation looping in existing Morro Bay-Midway #1 and #2 230kV lines	Interconnect generators
Santa Barbara	83	None	
N/A	N/A	New Gregg 500kV substation with two 500/230kV transformer banks and new Midway-Gregg 500kV DCTL	Mitigate normal and contingency overloads on Path 15 lines

Other Areas			
Westlands	50	None	Model at Westlands 115-kV substation
San Diego	21	None	Interconnected at Border substation
Sylmar	10	None	Model at Sylmar 230 kV substation
Stockton	45	None	Model at Stagg 230 kV bus
McFarland	44	None	Model at Semitropic 115 kV bus
Petaluma	5	None	Model at Lakeville 230 kV
Hanford	2	None	Model at Henrietta 115 kV bus

8.3.4 Results

CTPG's analysis found a number of reliability criteria violations under the assumed system conditions that were studied. The contingency basis of those violations, and possible mitigation for some of those violations, is shown in Appendix 1. Table 4 lists the bulk transmission facilities (generally 230 kV and above) on which thermal overloads were identified. Transmission infrastructure additions that would mitigate some of those thermal overloads are also summarized in Table 4. CTPG has not explored a full range of wires and non-wires alternatives for mitigating identified reliability criteria violations and invites stakeholders to propose such alternatives.

Table 4: Bulk transmission facilities for which thermal overloads were identified.

Area	Bulk Transmission Facility	Possible Mitigation
IID	El Centro-Imperial Valley 230-kV Line	El Centro-Imperial Valley Project
IID	Coachella-MI46Coach 230-kV Line	Highline-El Centro double-circuit 230-kV line
IID	Coachella-Midway X 230-kV Line	
IID	Midway X-MI46Coach 230-kV Line	
IID	Ramon-Mirage 230-kV Line	

SDG&E	Imperial Valley-ROA 230-kV Line	Open lines and trip IV generation (existing SPS)
SDG&E	Otay Mesa-Tijuana 230-kV Line	
SCE	Devers-San Bernardino 230-kV Line	West of Devers Upgrades
SCE	Devers-El Casco 230-kV Line	
SCE	Devers-Vista 230-kV Line	
SCE	El Casco-San Bernardino 230-kV Line	
SCE	Eldorado-Pisgah 500-kV Line	Upgrade series capacitors
SCE	Lugo-Llano #1 500-kV Line	Upgrade wave traps in Lugo-Llano and Llano-Vincent lines and drop generation (about 900 MW) in Kramer area for Llano-Lugo N-1
SCE	Lugo-Llano #2 500-kV Line	
SCE	Llano-Vincent #1 500-kV Line	
SCE	Llano-Vincent #2 500-kV Line	
SCE	Pisgah-Lugo 230-kV Line	Loop Mohave-Lugo 500-kV Line into Pisgah
LADWP	Rinaldi-Fairmont 500-kV Line	Upgrade terminal equipment at Rinaldi
LADWP	Toluca #1 or #2 500/230-kV Transformer	Cross trip remaining Toluca transformer (existing SPS)
LADWP	Victorville-Lugo 500-kV Line	Upgrade terminal equipment at Victorville and raise towers [32]
PG&E	Warnerville-Wilson 230-kV Line	Reconductor line
PG&E	Westley-Los Banos 230-kV Line	Reconductor line
PG&E	Borden-Gregg 230-kV Line	Reconductor line

[32] Other potential “upgrade” options to mitigate overloads on this line have been identified by LADWP and include adjusting the series compensation in parallel 500-kV lines or building a second Victorville-Lugo line.

8.4 RETI West of River Stress Scenario – Northern California Peak with Heavy South-to-North Bulk System Flows (WOR_A2sn)

8.4.1 Case Description

This case was started from the 2019 WECC heavy summer power flow case and modified to model 2020 summer peak load forecast for 1-in-10 year adverse weather conditions in northern California and Path 15 and Path 26 flows of 4,195 MW and 1,803 MW in the south-to-north direction, respectively. Renewable "net short" resources added to the resultant case to achieve California's 33 percent renewable portfolio standard were based on those outlined in the "RETI West of River Stress Scenario" and are summarized by technology and location in Table 2. .

8.4.2 Case Objective

The objective of the RETI West of River Stress Scenario base case is to identify transmission upgrades that will mitigate reliability criteria violations that may arise as a result of the RETI West of River Stress Scenario renewable resource additions during heavy south-to-north flows on Path 15 and Path 26 under northern California peak load conditions.

8.4.3 Grid Configuration

Table 1 lists major path flows both before and after the addition of the renewable generation. Table 2 summarizes the energy contribution from renewable resources by technology and location that would meet the projected year 2020 renewable net short.

Several grid configuration changes were made to the 2019 WECC "heavy summer" power flow case to connect the RETI West of River Stress Scenario renewable resource additions to the grid and to add network transmission facilities required to obtain a power flow solution. Table 3 lists the grid configuration changes.

Table 1: Major Inter-tie Flows

Path Name	Current Rating (MW)	Flow in A1 Case (MW)	Flow in A2 Case (MW)
COI	4800	183 (N-S)	687 (S-N)
Path 15	3265 (N-S) 5400 (S-N)	4,195 (S-N)	7,607 (S-N)
Path26	4000 (N-S) 3000 (S-N)	1,803 (S-N)	4,561 (S-N)
EOR	9300	5,670	5,213
WOR	10623	7,584[33]	10,459
PDCI	3100	586 (S-N)	586 (S-N)
IPP DC	2400	1,738 (S-N)	1,738 (S-N)

[33] It is noted that the modeled WOR flows in the A1 case are very close to 7,250 MW that was the maximum flow measured over the Path during the summer of 2010.

Table 2: Energy contribution from renewable resources by type and location to meet the net short

	Installed	Dispatched	Energy (GWh)
Resources by Technology			
Wind	7,650	2,406	22,732
PV	4,081	2,834	9,808
Bio	200	179	960
Solar Th.	6,853	5,107	16,734
Geo	350	315	2,530
Total	19,134	10,841	52,764
Resources by Location			
California	10,057	6,895	25,901
"WOR Hubs" [34]	7,525	3,667	22,728
Other OOS	1,552	279	4,135
Total	19,134	10,841	52,764

Table 3: CREZ installed capacity and network connection

CREZ/Renewable Development Area			
Location	CTPG – Identified Renewable Resource Addition: Installed Capacity (MW)	Grid Configuration Changes	Reason for Adding
Fairmont	692	none	
Imperial North-A	239	Build new Geo ("Hudsontap") 230kV substation (connect to Midway 230kV substation)	Interconnect generators,
Imperial South	389	None	
Iron Mountain	150	None	

[34] Renewable power injections modeled at Eldorado, Palo Verde, and North Gila 500-kV busses.

Mountain Pass	267	Build new IVANPAH 230/115kV substation looping in existing 115kV Coolwater-Dunn Siding–Baker-Mountain Pass-Eldorado line	Interconnect generators,
Mountain Pass	144	Build new Primm 230kV substation (just into western Nevada along I-15)	Interconnect generators,
Palm Springs	77	None	
Pisgah-A	500	Build new Pisgah 500 kV substation looping in existing 500 kV Eldorado-Lugo #1 line creating an existing 500 kV Eldorado-Pisgah #1 line and an existing 500 kV Pisgah-Lugo #1 line.	Interconnect generators, and mitigate normal and emergency overloads
Riverside East	781	Build new Colorado River 500 kV substation looping-in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Palo Verde-Colorado River #1 line and a 500 kV Colorado River-Red Bluff #1 line. Add two 500/230 kV transformers	Interconnect generators, and mitigate normal and emergency overloads
Riverside East	260	Build new Red Bluff 500 kV substation looping in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Colorado River-Red Bluff #1 line. Add one 500/230 kV transformer.	Interconnect generators, and mitigate normal and emergency overloads
San Bernardino - Lucerne	42	Build new Lucerne 230 kV substation in the San Bernardino-Lucerne CREZ (connect to grid with a 230 kV Lucerne-Lugo #1 line.)	Interconnect generators,
Kramer	1,367	1. New Kramer 500kV substation (upgrade from the existing 230kV substation 2. Two Kramer 500/230kV transformers 3. New LLANO 500kV switching station 4. Lugo - Vincent #2 500kV line looped into LLANO 500kV switching station 5. New Kramer - LLANO 500kV line	Interconnect generators, and mitigate normal and emergency overloads
Round Mt - A	67	None	
Round Mt - B	78	None	
San Diego south	118	Build new Windfarm ("ECO") 500 kV substation looping in existing 500 kV Imperial Valley-Miguel #1 line.	Mitigate emergency overloads
Solano	38	None	

Tehachapi	3,728	All segments of TRTP	TRTP project
Westlands	50	None	
Carrizo South	849	Build new Carrizo 230kV substation looping in existing Morro Bay-Midway #1 and #2 230kV lines	Interconnect generators
Santa Barbara	83	None	
N/A	N/A	1. New Gregg 500kV substation with two 500/230kV transformer banks, 2. New Eastside 500kV substation with one 500/230kV transformer bank, 3. New Midway-Gregg 500kV DCTL, 4. New Gregg-Eastside 500kV DCTL, 5. New Eastside-Tesla 500kv SCTL and 6. Eastside-Tracy 500kV SCTL	Mitigate normal and emergency overloads on Los Banos-Midway and Gates-Midway 500kV lines (Path 15)

8.4.4 Results

CTPG's analysis found a number of reliability criteria violations under the assumed system conditions that were studied. The contingency basis of those violations, and possible mitigation for some of those violations, is shown in Appendix A. Table 4 lists the bulk transmission facilities (generally 230 kV and above) on which thermal overloads were identified. Transmission infrastructure additions that would mitigate some of those thermal overloads are also summarized in Table 4. CTPG has not explored a full range of wires and non-wires alternatives for mitigating identified reliability criteria violations and invites stakeholders to propose such alternatives.

Table 4: Bulk transmission facilities for which thermal overloads were identified.

Area	Bulk Transmission Facility	Possible Mitigation
LADWP	LUGO-VICTORVL #1 500KV LINE	Upgrade terminal equipment at Victorville and raise towers [35]
LADWP	SCATERGD-OLYMPC #2 230KV LINE	Construct a new SCATERGD-OLYMPC 230kV line. The need to construct the new line was already identified in the recent LADWP ten-year transmission assessment.

[35] Other potential "upgrade" options to mitigate overloads on this line have been identified by LADWP and include adjusting the series compensation in parallel 500-kV lines or building a second Victorville-Lugo line.

LADWP	BARRENRD - HSKLLCYN #3 230KV LINE	Run back generation at Castaic
LADWP	HSKLLCYN - SYLMARLA #1 230KV LINE	Reconductor
LADWP	SYLMARLA-HSKLLCYN #1 230KV LINE	Reconductor
PG&E	MIDWAY-WIRLWIND #3 500KV LINE	Build Kramer-Midway 500kV line
PG&E	BELLOTA-COTTLE B 230KV LINE	Rebuild the 230kV line with higher capacity
PG&E	BORDEN-GREGG #1 230KV LINE	Rebuild the 230kV line with higher capacity
PG&E	STOREY 1-GREGG #1 230KV LINE	Rebuild the 230kV line with higher capacity
PG&E	COTTLE B-WARNERVL #1 230KV LINE	Rebuild the 230kV line with higher capacity
PG&E	LOSBANOS-WESTLEY #1 230KV LINE	Rebuild the 230kV line with higher capacity
PG&E	METCALF - MOSSLND1 #1 & #2 230 KV Lines,	Run-back Moss Landing generation
PG&E	AEC_TP1 – SFWY_TP1 115KV LINE	Dispatch local generation
PG&E	VSC_PTSB 230/180KV TRANSFORMER	Run-back Trans Bay Cable transfer
SCE	ELDORDO-PISGAH #1 500KV LINE	Upgrade 500kV series capacitors on the ELDORDO - PISGAH 500KV line
SCE	BARRE - ELLIS #1 230KV LINE	Reconductor, upgrade the rating, dispatch local generators, or build new transmission line into Western LA Basin.
SCE	SANBRDNO-DEVERS #1 230KV LINE	West of Devers upgrades
SCE	KRAMER-LUGO #1 and #2 230KV LINES	Revise SPS of tripping North of Lugo generation
SCE	DEVERS-EL CASCO #1 230KV LINE	West of Devers upgrades
SCE	PISGAH -LUGO #1 230KV LINE	Loop Mojave-Lugo 500kV line into Pisgah
SCE	DEVERS -VSTA #1 230KV LINE	West of Devers Upgrades
SCE	DEVERS -VSTA #2 230KV LINE	West of Devers Upgrades
SCE	LEWIS -VILLA PK #1 230KV LINE	Reconductor, upgrade the rating, dispatch local generation, or build new line into western LA Basin
SDG&E	IMPRLVLY-N.GILA #1 500KV LINE	Upgrade 500kV series capacitors on the IMPRLVLY -N.GILA 500KV line

SDG&E	ESCNDIDO - TALEGA #1 230 KV Line,	SPS (controlled load drop)
SDG&E	OTAYMESA-TJI-230 #1 230KV LINE	SPS (transfer trip IV gen and IV-ROA 230 or Otay Mesa-TJI 230kV lines
SDG&E	IMPRLVLY - ROA-230 #1 230 KV Line,	SPS (Transfer trip IV gen and IV-ROA230 or OtayMesa-TJI 230kV lines)
SDG&E	SYCAMORE 230/138KV #1 TRANSFORMER	Build a new Sycamore-Penasquitos 230kV line
IID	COACHELV-MI46COCH #1 230KV LINE	1. HIGHLINE-ELCENTRO 230KV DCTL 2. IMPRLVLY-IIDIVSUB 230KV DCTL.
IID	MI46COCH-MIDWAY X #1 230KV LINE	1. HIGHLINE-ELCENTRO 230KV DCTL 2. IMPRLVLY-IIDIVSUB 230KV DCTL.

9 Evaluation of CTPG Scenario Results:

9.1 Transmission Upgrades Identified in Connection with the West of River Stress Scenario

In evaluating the results for the West of River Stress Scenario it is important to have an understanding of the assumptions underlying certain path flows prior to the addition of the renewable resource development portfolio, and the implications of those assumptions. The following table summarizes path flows for the four cases that CTPG assembled for the West of River Stress Scenario.

	West of River Stress Scenario Southern California Peak (WOR_B2SW) (5:00 pm PST in July, 2020)			West of River Stress Scenario Northern California Peak with Heavy South-to-North Bulk System Flows (WOR_A2sn) (5:00 pm PST in July, 2020)			West of River Stress Scenario Autumn Off-Peak (WOR_F2-6700) (9:00 am PST in Sept., 2020)			West of River Stress Scenario Autumn Off-Peak (WOR_F2) (9:00 am PST in Sept., 2020)		
	Path 15	**Path 26**	**WOR**	**Path 15**	**Path 26**	**WOR**	**Path 15**	**Path 26**	**WOR**	**Path 15**	**Path 26**	**WOR**
Existing Path Rating	**3265 N-S 5400 S-N**	**4000 N-S 3000 S-N**	**10623 E-W**	**3265 N-S 5400 S-N**	**4000 N-S 3000 S-N**	**10623 E-W**	**3265 N-S 5400 S-N**	**4000 N-S 3000 S-N**	**10623 E-W**	**3265 N-S 5400 S-N**	**4000 N-S 3000 S-N**	**10623 E-W**
Flows in 2019 WECC Heavy Summer "Seed Case"	**713 S-N**	**1944 N-S**	**5297**	**713 S-N**	**1944 N-S**	**5297**	**713 S-N**	**1944 N-S**	**5297**	**713 S-N**	**1944 N-S**	**5297**
Flows *prior to* addition of renewable resource development portfolio	**1011 S-N**	**2281 N-S**	**7130**	**4195 S-N**	**1803 S-N**	**7584**	**598 S-N**	**1355 N-S**	**6700**	**5032 S-N**	**2164 S-N**	**10085**
Flows *after* addition of renewable resources and	**1344 S-N**	**1893 N-S**	**9799**	**7607 S-N**	**4561 S-N**	**10459**	**2328 S-N**	**89 N-S**	**8963**	**5495 S-N**	**3164 S-N**	**11927**

associated fossil-fired decrements												

As shown in the above table the four cases used as part of the CTPG studies represent a wide range of flows on Path 15, Path 26, and the West-of-River (WOR) Path. For example, pre-renewable flows on the WOR path range from 6700 MW to 10085 MW.

By way of comparison, historical data for 2010 for the WOR Path indicates that the maximum annual flow was 8461 MW while the average annual flow was 5136 MW. During the summer months of June through September—which encompasses the assumed time for the on-peak cases—the recorded maximum flow was 7251 MW and the recorded average flow was 4630 MW. For the 9:00 am PST hour in the month of September—which is the assumed time for the Autumn cases—the recorded maximum flow was 6609 MW and the recorded average flow was 5787 MW.

The pre-renewable flow for the WOR_F2 case is therefore 4298 MW (10085 MW less 5787 MW) higher than the average recorded flow for all 9:00 am PST hours in September and 1624 MW (10085 MW less 8461 MW) higher than the highest recorded flow during any hour of the year. Naturally, the higher the level of pre-renewable path flow, the more likely it is that adding renewable resources will result in finding reliability criteria violations and therefore the identification of transmission infrastructure additions to mitigate those violations. Since the pre-renewable level of path flows has a direct bearing on the identification of transmission infrastructure additions, it is important to understand (i) the rationale for assuming different levels of pre-renewable path flows in the power flow studies, and (ii) the implications for the results of those studies.

It should also be noted that the existing rating for the WOR Path is based on the existing configuration for the Path which includes seven 500-kV lines and seven 230-kV/287-kV lines. On the other hand the studies performed by the CTPG assumed that the Colorado River-Devers 500-kV line (which has been conditionally approved by both the CPUC and the CAISO) would be in-service. The addition of this line could (according to the WECC 2010 Path Rating Catalog) increase the rating of the WOR Path to approximately 11,800 MW.

NERC reliability standards require a broad assessment of possible system conditions and require that corrective actions be identified for all potential reliability criteria violations identified. For example, the NERC Standards require that system performance must meet requirements over "all demand levels,"[36] and prohibit operating at levels which have not been studied. Thus it is appropriate to evaluate system conditions that may be outside the range of what has actually been experienced and to identify corrective actions—such as new transmission infrastructure—to mitigate any reliability criteria violations that could arise under those system conditions.

Identifying the *possibility* of a reliability criteria violation under a particular system condition does not, however, mean that any particular corrective action is the best course of action considering the interests of consumers that will ultimately be responsible for the costs of the corrective action and that will be subject to the environmental consequences of the corrective action. Consumers will want the corrective action that provides the greatest benefit for the lowest cost. This suggests that consumers would be unwilling to pay a high cost for those corrective actions that are expected to be needed on an infrequent basis unless the corrective action is projected to provide other benefits to consumers that offset the high cost.

[36] In practice, transmission planners perform studies for those representative demand levels where the reasonably foreseeable worst problems are expected to occur and use engineering judgment for the rest of the demand levels. The intent is that the system will be reliable under all foreseeable conditions. This practice complies with NERC Standards and Measurements, wherein the Standard states that system performance must be met under "all demand levels" and the Measurement by which this Standard is met shall include "System performance assessments based on simulation testing …. for selected demand levels over the range of forecast system demands." FERC Order 693 requires that "critical system conditions and study years be determined by conducting sensitivity studies with due consideration of the range of factors …"

The likelihood that any studied system condition will actually come to pass, and the projected benefits of corrective actions associated with the studied system condition (relative to other alternatives), are therefore important factors in determining which corrective action should be pursued. If the level of pre-renewable path flows assumed for a particular power flow study is much higher than historical path flows, it is reasonable to assume that the likelihood of that system condition actually coming to pass is low, and any corrective actions identified in connection with that system condition would need to be relatively inexpensive or have a high level of projected benefits for consumers (relative to other alternatives).

It is also true that historical path flows may not be a good indicator of future path flows. This may suggest the need for hourly economic grid simulation or other modeling which accounts for the full range of expected system conditions across an entire year, for several future years and several different resource scenarios to capture the facts that transmission assets have long lives and that generation dispatch conditions can change. These simulations can provide information, upon which to develop recommendation(s) for corrective action plans that provide the highest level of expected benefits for consumers.

To date CTPG has not undertaken any hourly economic grid simulation or other similar analyses so has no analytical basis for concluding that future path flows, absent the addition of renewable resources, would be more or less than historical path flows. CTPG recommends that readers consider these implications when examining the results of the different cases presented in the Phase 4 study report.

9.2 Sensitivity Analysis on the Potential Impacts of the Development of 5,000 MW of Solar in the Westlands CREZ

9.2.1 Background

As part of its Phase 3 Study effort the CTPG performed powerflow studies to assess system impacts if the energy required to meet the estimated "net short" in 2020 (approximately 52,800 GWH) was provided by resources presented in RETI's "best CREZ" renewable resource development portfolio. The location and amounts of such resources identified in the Best CREZ's are summarized in Table 1.

TABLE 1
RENEWABLE RESOURCES MODELED IN RETI "BEST CREZ" SCENARIOS

CREZ/Renewable Development Area	Installed Capacity (MW)	Dispatched Capacity [37] (MW)	Annual Energy (GWH)
Southern California			
Fairmont	1,345	927	3,555
Imperial North	696	626	5,126
Kramer	3,256	2,444	7,507
Mountain Pass	565	356	1,376
Owens Valley	187	187	1,259
San Diego South	344	112	929
Tehachapi	5,294	3,711	12,914
Sub-Total	***11,687***	***8,363***	***32,666***

[37] Assumed to be 5:00 pm PST in mid-July, 2020

Central California			
Westlands	2,539	2,031	4,223
Northern California			
Round Mountain	195	175	1,298
Solano	454	296	1,382
Sub-Total	***649***	***471***	***2,680***
Total – In-State	***14,875***	***10,865***	***39,569***
Out-of-State	4,026	1,283	13,194
Total Resources	***18,901***	***12,148***	***52,763***

As shown in Table 1 the "RETI Best CREZ" scenarios assessed by the CTPG included:

- Approximately 8,360 MW of dispatched capacity and approximately 32,700 GWH of energy (approximately 62% of the net short) in Southern California.
- Approximately 2,540 MW of installed capacity in the Westlands CREZ in Central California. Approximately 2,030 MW (80%) of this capacity was dispatched and the resultant energy was approximately 4,220 GWH (8% of the net short).
- Approximately 470 MW of dispatched capacity and 2,680 GWH of energy (approximately 5% of the net short) in Northern California.
- Approximately 1,280 MW of dispatched capacity and approximately 13,190 GWH (approximately 25% of the net short) from out-of-state resources.

The above renewables were added to a powerflow case (the "A1" Case) which modeled peak loads (1-in-10 year) loads in Northern California and approximately 1-in-2 year loads in Southern California to create the "A2" Case[38]. Table 2 presents information on the flows over major transmission paths in both the A1 and A2 Cases.

TABLE 2
MAJOR INTERTIE RATINGS AND FLOWS

Path Name	Path Rating (MW)	Case A-1 Flows (MW)	Case A-2 Flows (MW)	Change In Flows (MW)
COI	4,800 (N-S) 3,675 (S-N)	135 (S-N)	778 (S-N)	643
Path 15	3,265 (N-S) 5,400 (S-N)	5,158 (S-N)	7,325 (S-N)	2,167
Path 26	4,000 (N-S) 3,000 (S-N)	2,134 (S-N)	2,325 (S-N)	191
EOR	9,300 (E-W)	4,977 (E-W)	4,166 (E-W)	(811)
WOR	10,623 (E-W)	4,370 (E-W)	3,882 (E-W)	(488)
PDCI	3,100 (N-S) 3,100 (S-N)	586 (S-N)	586 (S-N)	0
IPP DC	2,400 (N-S)	1,738 (N-S)	1,738 (N-S)	0

As shown in Table 2 the addition of the Best CREZ renewable resources (and the associated re-dispatch of both in-

38 In the A2 Case the resources in the Westlands area were modeled as a single generator at a new Westlands 500-kV bus which was, in turn, interconnected with the Gates Substation via a double-circuit 500-kV line.

state and out-of-state thermal resources[39]):

- Increased the north-bound flows over the COI, Path 15, and Path 26 transmission paths. The most significant increase (approximately 2,170 MW) occurred on Path 15 and resulted in the flows over the Path exceeding the Path's existing rating by approximately 1,930 MW.
- Decreased the west-bound flows over both the EOR and WOR Paths.

The following transmission additions were modeled in the A2 Case to mitigate both normal and emergency overloads noted on the existing Path 15 facilities and to facilitate the delivery of renewables to load centers within Northern California:

- Expanding the Gregg substation to include a 500-kV switchyard and two 500/230 kV transformers
- Midway-Gregg double-circuit 500-kV line
- Eastside 500/230-kV substation
- Gregg-Eastside double-circuit 500-kV line
- Eastside-Tesla single-circuit 500-kV line
- Eastside-Tracy single-circuit 500-kV line

In addition to the above, powerflow studies on the A2 Case indicated that upgrades of the following 230-kV lines in Northern California would be necessary to mitigate normal and/or emergency overloads occurring on them:

- Bellota-Cottle B-Warnerville
- Borden-Gregg
- Los Banos-Westley
- Storey-Gregg

9.2.2 Impacts of 5,000 MW of Generation in the Westlands Area

The Sierra Club's comments on the CTPG Phase 4 Study Plan reference the possible addition of 5,000 MW of installed solar generating capacity in the Westlands area. The impact of this amount of solar generating capacity on the transmission grid depends upon which other potential renewable resources would not be developed if the Westlands CREZ is developed at the 5000 MW level (i.e., what the resulting renewable resource development portfolio would look like).[40] To date CTPG has not developed a scenario representing 5,000 MW of installed Westlands generating capacity, nor has CTPG conducted the powerflow studies to assess the resultant system impacts.

Based on the background information discussed above it appears likely that a majority of renewables that would not be developed if the Westlands CREZ is developed at the 5000 MW level would be located in Southern California or outside of California. This is due to the fact that, in the A2 Case discussed above, a very small portion (4-5%) of the annual energy required to meet the net short was from renewable resources located in Northern California. Assuming that the pattern of fossil-fired generation which is backed-down to accommodate the output of this

[39] Approximately 70% of the thermal re-dispatch involved in-state thermal units.

[40] Different renewable resource development portfolios will have different impacts on the grid. On an expected basis, different renewable technologies deliver different portions of their installed capacity at different times, e.g., wind might provide 5% of installed capacity at time of system peak, while solar thermal provides 80% and solar photovoltaic 30%. There will be corresponding differences in the pattern of fossil-fired generation which is backed-down to accommodate the output of a particular renewable resource portfolio.

renewable resource portfolio is largely unchanged, it is likely that the resultant power flows:

- Could result in significant loading increases on portions of the existing in Central or Northern California that could require transmission upgrades in addition to those discussed above.
- Could reduce the impacts on the system in Southern California due to the decreased amounts of renewable resources modeled in that area. The degree to which such reduced impacts would impact the need for upgrades to the system in Southern California has not been assessed.

On the other hand, if the pattern of fossil-fired generation which is backed-down to accommodate the output of this renewable resource portfolio is markedly different (for example, less fossil-fired generation in northern California and more in southern California or vice versa) , the above expectations may not hold.

In its comments on CTPG's Draft Phase 4 Study Plan the Sierra Club suggested that "...the Westlands area be evaluated closely by the CTPG for potential transmission upgrades..." if 5,000 MW of generation was developed in the area. In its response of December 17, 2010 to the Sierra Club's comments CTPG noted that it will consider such suggested transmission evaluations as it develops its study plans for year 2011.

9.3 High Potential" Transmission Upgrades: Estimated Progress Towards Meeting California's 33% Renewable Portfolio Standard (RPS) Goal in Year 2020

9.3.1 Objective of Analysis

Stakeholders have asked CTPG to estimate the extent to which the "high potential" transmission upgrades identified in Appendix C in the final Phase 3 study report would support attainment of California's 33% RPS goal in year 2020. CTPG has performed power flow analysis, with the high potential transmission upgrades in place, to estimate the amount of renewable resources that can be dispatched without any contingency-based thermal overloads for the dispatch conditions studied and the contingencies simulated. CTPG emphasizes that this analysis is designed only to evaluate the *capability* of the existing transmission system plus "high potential" transmission upgrades identified in Phase 3 to accommodate increased levels of renewable resource development; it should not be interpreted as implying anything about the *likelihood* that the modeled patterns of renewable resource development will in fact occur

9.3.2 Methodology

To estimate the amount of renewable resources that could potentially be dispatched without any thermal overloads for the contingencies simulated, CTPG first identified those CREZs that would be connected to the existing grid with the "high potential" transmission upgrades identified in Phase 3. Table A shows the selected CREZs, the corresponding high potential transmission upgrades that connect these CREZs to the existing grid, the maximum amount of installed capacity within these CREZs, and the maximum dispatched capacity at 4:00 pm in mid-July, 2020 (a summer peak load case). Table B shows the maximum dispatched capacity at 9:00 am in mid-September, 2020 (an off-peak "autumn" case). The tables also include CREZs and renewable resource development areas whose connections to the existing grid are not dependent on CTPG-identified connection facilities or CTPG-identified network upgrades.

For purposes of this analysis, CTPG has evaluated generators included in the generator interconnection queue portfolio as this is the 33% RPS portfolio used in the filtering methodology that identified the "high ranking" CREZs (the "high ranking" CREZs, in turn, were used in the process that selected the "high potential" and "medium potential" network upgrades).[41] [42]

Note that because CTPG's "high potential" and "medium potential" transmission upgrade identification methodology used the generator interconnection queue portfolio (which only included generator interconnection queues for utilities with retail loads located exclusively in California) as a filter for selecting CREZs with high commercial interest, there is, by definition, a limited number of out-of-state renewable generators included in the analysis.

Note further that the Aspen "discounted core" renewable resource development portfolio was also used in the filtering process. This portfolio does not include any renewable generation that may be contracted to municipal utilities within the state of California. Including this renewable generation could result in the identification of additional "high ranking" CREZs.

[41] While different renewable resource development portfolios could be used to estimate the amount of renewable resources that can be dispatched without any contingency-based thermal overloads, the chosen portfolio needs to contain enough renewable resource capacity to support California's 33% RPS goal. If the chosen portfolio contained a smaller amount of renewable resource capacity (for example, the Aspen "discounted core" portfolio), a determination of how much renewable resource development the high potential transmission upgrades are capable of accommodating without a thermal reliability criteria violations could be compromised by the limit on renewable resource development potential imposed by the choice of renewable resource development portfolio.

[42] See section 10 of the Phase 3 final study report for a description of the methodology used to identify "high potential" and "medium potential" transmission upgrades.

Table A

New Renewable Generation in the Generator Interconnection Queue Portfolio

		New Renewable Generation in Generator Interconnection Queue Portfolio							
		Installed Capacity				Maximum Possible Dispatched Capacity at 4:00 pm PST in mid-July, 2020			
Connected CREZs	**High Potential Transmission Upgrade Connecting CREZ to Existing Grid**	**Wind (MW)**	**Solar (MW)**	**Biomass (MW)**	**Geothermal (MW)**	**Wind (MW)**	**Solar (MW)**	**Biomass (MW)**	**Geothermal (MW)**
Carrizo South	Build new Carrizo1 230 kV substation looping in existing 230 kV Morro Bay-Midway #1 and #2 lines.		221	7			185	7	
Geysers	Use existing connection facilities				32				29
Imperial South	Build new IID Imperial Valley 230 kV substation looping in (i) the existing 230 kV Imperial Valley-El Centro #1 line (creating a 230 kV IID Imperial Valley-El Centrol #1 line and a 230 kV Imperial Valley-IID Imperial Valley #1 line), and (ii) the planned 230 kV Imperial Valley-Dixieland #1 line (creating a 230 kV IID Imperial Valley-Dixieland #1 line and a 230 kV Imperial Valley-IID Imperial Valley #2 line).	91	1952	33		28	1176	30	
Mountain Pass	Build new (i) Ivanpah ("Mountain Pass") 230/115 kV substation looping-in existing 115 kV Coolwater-Dunn Siding-Baker-Mountain Pass-El Dorado line. Creates an existing 115 kV Coolwater-Dunn Siding-Baker-Ivanpah ("Mountain Pass") line, and (ii) new Primm 230 kV substation (just into western Nevada along I-15).		656				432		
Nevada South	Build new Primm 230 kV substation (just into western Nevada along I-15) PLUS use existing connection facilities		487				359		
Palm Springs	Use existing connection facilities	183				103			
Pisgah	Build new 500 kV Pisgah substation looping in existing 500 kV El Dorado-Lugo #1 line creating an existing 500 kV El Dorado-Pisgah #1 line and an existing 500 kV Pisgah-Lugo #1 line.		781				583		
Riverside East	Build new Colorado River 500 kV substation looping-in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Palo Verde-Colorado River #1 line and a 500 kV Colorado River-Red Bluff #1 line. Add two 500/230 kV transformers.		2527				1644		
Round Mountain-A	Use existing connection facilities	94				22			
San Diego	Use existing connection facilities			25				22	
Santa Barbara	Use existing connection facilities	110				37			
Solano	Build new Collinsville 500/230 kV substation looping in existing 500 kV Vaca Dixon-Tesla #1 line. (Collinsville sub serves same function as a new Solano 500 kV substation)	555				362			
Tehachapi	Use existing connection facilities	3667	1966			2217	1460		
	TOTALs	**4700**	**8591**	**65**	**32**	**2768**	**5839**	**59**	**29**

Table B

New Renewable Generation in the Generator Interconnection Queue Portfolio

		New Renewable Generation in Generator Interconnection Queue Portfolio							
		Installed Capacity				Maximum Possible Dispatched Capacity at 9:00 am PST in mid-September, 2020			
Connected CREZs	High Potential Transmission Upgrade Connecting CREZ to Existing Grid	Wind (MW)	Solar (MW)	Biomass (MW)	Geothermal (MW)	Wind (MW)	Solar (MW)	Biomass (MW)	Geothermal (MW)
Carrizo South	Build new Carrizo1 230 kV substation looping in existing 230 kV Morro Bay-Midway #1 and #2 lines.		221	7			183	7	
Geysers	Use existing connection facilities				32				29
Imperial South	Build new IID Imperial Valley 230 kV substation looping in (i) the existing 230 kV Imperial Valley-El Centro #1 line (creating a 230 kV IID Imperial Valley-El Centrol #1 line and a 230 kV Imperial Valley-IID Imperial Valley #1 line), and (ii) the planned 230 kV Imperial Valley-Dixieland #1 line (creating a 230 kV IID Imperial Valley-Dixieland #1 line and a 230 kV Imperial Valley-IID Imperial Valley #2 line).	91	1952	33		15	1560	30	
Mountain Pass	Build new (i) Ivanpah ("Mountain Pass") 230/115 kV substation looping-in existing 115 kV Coolwater-Dunn Siding-Baker-Mountain Pass-El Dorado line. Creates an existing 115 kV Coolwater-Dunn Siding-Baker-Ivanpah ("Mountain Pass") line, and (ii) new Primm 230 kV substation (just into western Nevada along I-15).		656				553		
Nevada South	Build new Primm 230 kV substation (just into western Nevada along I-15) PLUS use existing connection facilities		487				411		
Palm Springs	Use existing connection facilities	183				38			
Pisgah	Build new 500 kV Pisgah substation looping in existing 500 kV El Dorado-Lugo #1 line creating an existing 500 kV El Dorado-Pisgah #1 line and an existing 500 kV Pisgah-Lugo #1 line.		781				699		
Riverside East	Build new Colorado River 500 kV substation looping-in existing 500 kV Palo Verde-Devers #1 line creating a 500 kV Palo Verde-Colorado River #1 line and a 500 kV Colorado River-Red Bluff #1 line. Add two 500/230 kV transformers.		2527				2135		
Round Mountain-A	Use existing connection facilities	94				11			
San Diego	Use existing connection facilities			25				22	
Santa Barbara	Use existing connection facilities	110				6			
Solano	Build new Collinsville 500/230 kV substation looping in existing 500 kV Vaca Dixon-Tesla #1 line. (Collinsville sub serves same function as a new Solano 500 kV substation)	555				201			
Tehachapi	Use existing connection facilities	3667	1966			519	1732		
	TOTALs	**4700**	**8591**	**65**	**32**	**789**	**7273**	**59**	**29**

Once the connected CREZs were identified, CTPG modeled the generation within these CREZs (see Tables A and B) in the power flow cases developed for (i) the Phase 2 "B-Q" scenario, (ii) the Phase 2 "A-Q" scenario, and (iii) the Phase 3 "F" scenario (the off-peak "autumn" scenario). The power flow cases were modified to only include the "high potential" transmission upgrades. (A description of the system conditions underlying the B-Q and A-Q powerflow cases is provided in sections 7.4 and 7.2 of the final Phase 2 study report. A description of the system conditions underlying the F powerflow case is provided in section 7.7 of the final Phase 3 study report.) As shown on Table A the total amount of renewable generation dispatched in the A-Q and B-Q cases was 8695 MW and included 2768 MW of wind, 5839 MW of solar, 59 MW of biomass, and 29 MW of geothermal resources. As shown on Table B the total amount of renewable generation dispatched in the F cases was 8150 MW and included 789 MW of wind, 7273 MW of solar, 59 MW of biomass, and 29 MW of geothermal resources..

In all three cases, corresponding merit order-based reductions in fossil-fired generation were modeled subject to the constraint that approximately 70% of the fossil-fired decrements were within California and 30% of the reductions were outside the state. Various amounts and geographical patterns of dispatched renewable generating capacity within the identified CREZs and renewable resource development areas, with corresponding changes in fossil-fired generation dispatch, were tested to determine whether power flow solutions could be reached, and if so, whether contingencies would result in convergence failure or thermal overloads.

When a thermal overload was found, a small change to the amount and/or geographical pattern of dispatched renewable generating capacity was made (along with a corresponding change to the fossil-fired generation dispatch) and the modified case retested for thermal overloads. This iterative process stops when no contingency-based overloads are found. Using the B-Q scenario assumptions the limiting contingency is the outage of the 500 kV Imperial Valley-Miguel #1 line which overloads the emergency ratings of the 230 kV Central-Sycamore Canyon #1 and #2 lines. Using the A-Q scenario assumptions the limiting contingency is the outage of the 230 kV SONGS-Santiago #1 line which overloads the emergency rating of the 230 kV Barre-Ellis #1 line. Using the F scenario assumptions, the limiting contingency is the outage of the 500 kV Tesla-Los Banos #1 line overloading the emergency rating of the 230 kV Los Banos-Westley #1 line.

The amount of dispatched renewable capacity at the end of the iterative process is used to impute an equivalent amount of installed renewable capacity. The applicable hourly/monthly technology- and location-specific output profiles are used for this purpose. Once the installed capacity numbers are known, technology- and location-specific annual capacity factors are applied to calculate the annual energy production that would be accommodated by the existing transmission plus "high potential" transmission upgrades. The results of these calculations are shown in tables C, D and E below.

9.3.3 Results:

Using the system conditions of the B-Q, A-Q and F scenarios, tables C, D and E show the amount of renewable generation that can be dispatched within each CREZ without encountering a contingency-based thermal overload assuming the “high potential” transmission upgrades are in place and assuming that steps are taken to address any local area requirements that may exist in the future given anticipated changes to the existing grid configuration and generation fleet. Addressing such local area requirements could include transmission reinforcements in addition to the “high potential” upgrades.

For the studied system conditions, it is estimated that the high potential transmission upgrades will accommodate between 20,622 gWh and 27,443 gWh of new renewable resource development without any contingency-based thermal overloads. This represents between 22% and 24% of the forecast year 2020 retail loads and between 57% and 73% of the installed renewable generator capacity included in the generator interconnection queue and assumes that the levels of existing renewable resource energy production capability and other miscellaneous renewable resource additions shown on Tables C through E are being delivered.

CTPG reminds readers that the “high potential” transmission upgrades shown in Appendix C of the Phase 3 final study report document have not been compared to any other wires- or non-wires alternatives. Therefore it should not be assumed that these specific upgrades are “the final fixes,” i.e., further analysis may show that other wires- or non-wires alternatives are better solutions for cost-effectively supporting the state’s efforts to meet the 33% RPS goal in year 2020.

Table C
Renewable Generation in the Generator Interconnection Queue Portfolio that Can be Dispatched Without Contingency-Based Thermal Overloads Using System Conditions of CTPG's B-Q Scenario

	Dispatched Capacity w/o Overloads				Installed Capacity (equating to the amount of dispatched capacity w/o overloads at 4:00 pm PST in mid-July, 2020)				Annual Energy Production (from installed capacity equating to the amount of dispatched capacity w/o overloads at 4:00 pm PST in mid-July, 2020)				
Connected CREZs	**Wind (MW)**	**Solar (MW)**	**Bio, (MW)**	**Geo. (MW)**	**Wind (MW)**	**Solar (MW)**	**Bio. (MW)**	**Geo. (MW)**	**Wind (gWh)**	**Solar (gWh)**	**Bio. (gWh)**	**Geo. (gWh)**	**Total (gWh)**
Carrizo South		29	1			35	1			71	9		80
Geysers				5				5				40	40
Imperial South	4	185	5		14	306	5		38	674	41		752
Mountain Pass		78				118				266			266
Nevada South		56				76				177			177
Palm Springs	16				29				98				98
Pisgah		135				181				432			432
Riverside East		1644				2527				5615			5615
Round Mountain-A	22				94				253				253
San Diego			22				25				196		196
Santa Barbara	37				110				299				299
Solano	362				555				1699				1699
Tehachapi	2217	1460			3,667	1966			10799	4598			15398
Totals	**2,658**	**3,587**	**28**	**5**	**4,469**	**5,210**	**31**	**5**	**13,186**	**11,832**	**246**	**40**	**25,304**
Existing, Under Construction and Miscellaneous Renewable Resources:													41,529
Total Renewable Resources:													**66,833**
California Retail Sales in year 2020 subject to RPS Goal:													285,734
Renewables as a Percent of year 2020 Retail Sales:													23%
California's RPS Goal for year 2020:													33%

Table D
Renewable Generation in the Generator Interconnection Queue Portfolio that Can be Dispatched Without Contingency-Based Thermal Overloads Using System Conditions of CTPG's A-Q Scenario

	Dispatched Capacity w/o Overloads				Installed Capacity (equating to the amount of dispatched capacity w/o overloads at 4:00 pm PST in mid-July, 2020)				Annual Energy Production (from installed capacity equating to the amount of dispatched capacity w/o overloads at 4:00 pm PST in mid-July, 2020)				
Connected CREZs	**Wind (MW)**	**Solar (MW)**	**Bio, (MW)**	**Geo. (MW)**	**Wind (MW)**	**Solar (MW)**	**Bio. (MW)**	**Geo. (MW)**	**Wind (gWh)**	**Solar (gWh)**	**Bio. (gWh)**	**Geo. (gWh)**	**Total (gWh)**
Carrizo South		148	5			177	6			363	46		410
Geysers				23				26				204	204
Imperial South	22	945	24		73	1569	27		192	3450	210		3852
Mountain Pass		350				531				1194			1194
Nevada South		289				391				906			906
Palm Springs	83				147				501				501
Pisgah		468				628				1501			1501
Riverside East		1321				2031				4512			4512
Round Mountain-A	18				75				203				203
San Diego			18				20				157		157
Santa Barbara	30				89				240				240
Solano	296				454				1390				1390
Tehachapi	1781	1174			2947	1580			8678	3695			12373
Totals	**2,230**	**4,695**	**47**	**23**	**3,785**	**6,907**	**53**	**26**	**11,205**	**15,620**	**414**	**204**	**27,443**
Existing, Under Construction and Miscellaneous Renewable Resources:													41,529
Total Renewable Resources:													**68,972**
California Retail Sales in year 2020 subject to RPS Goal:													285,734
Renewables as a Percent of year 2020 Retail Sales:													24%
California's RPS Goal for year 2020:													33%

Table E
Renewable Generation in the Generator Interconnection Queue Portfolio that Can be Dispatched Without Contingency-Based Thermal Overloads Using System Conditions of CTPG's F Scenario

	Dispatched Capacity w/o Overloads				Installed Capacity (equating to the amount of dispatched capacity w/o overloads at 9:00 am PST in mid-September, 2020)				Annual Energy Production (from installed capacity equating to the amount of dispatched capacity w/o overloads at 9:00 am PST in mid-September, 2020)				
Connected CREZs	**Wind (MW)**	**Solar (MW)**	**Bio, (MW)**	**Geo. (MW)**	**Wind (MW)**	**Solar (MW)**	**Bio. (MW)**	**Geo. (MW)**	**Wind (gWh)**	**Solar (gWh)**	**Bio. (gWh)**	**Geo. (gWh)**	**Total (gWh)**
Carrizo South		101	4			123	4			251	32		283
Geysers				16				18				140	140
Imperial South	5	194	5		29	242	6		76	533	44		654
Mountain Pass		7				8				18			18
Nevada South													0
Palm Springs													0
Pisgah		28				32				75			75
Riverside East		904				1070				2378			2378
Round Mountain-A	7				63				169				169
San Diego			12				14				108		108
Santa Barbara	6				110				299				299
Solano	198				548				1675				1675
Tehachapi	519	1517			3667	1721			10,799	4,026			14,825
Totals	**734**	**2,751**	**21**	**16**	**4,416**	**3,196**	**23**	**18**	**13,018**	**7,281**	**184**	**140**	**20,622**
Existing, Under Construction and Miscellaneous Renewable Resources:													41,529
Total Renewable Resources:													**62,151**
California Retail Sales in year 2020 subject to RPS Goal:													285,734
Renewables as a Percent of year 2020 Retail Sales:													22%
California's RPS Goal for year 2020:													33%

10 Evaluation of High Potential Transmission Corridors

The California Transmission Planning Group (CTPG) initiated its study efforts in mid-2009 with the primary objective of providing the foundation for a state-wide transmission plan that identified the transmission infrastructure needed to reliably and efficiently meet the State's 33% Renewable Portfolio Standard (RPS) goal by the year 2020. A major challenge in the development of a definitive transmission plan has been and continues to be the uncertainty of the location of the renewable resources since the state's load serving entities have not completed their respective final procurement decisions for meeting a 33% RPS, nor is it likely that those final procurement decisions will be within the next several years.

In addition to uncertainties as to which of the renewable resource projects will be successful in obtaining permits and financing, the load serving entities procurement strategies are dependent on the outcome of legislation and rule making still being considered by state regulators and decision makers. These include green house gas reduction legislation; carbon emission levels [and renewable energy certificate rule making; state policy decisions on expanding energy efficiency, distributed generation, combined heating and power applications;, and decisions related to the disposition of coastal power plants using Once-through Cooling (OTC) technology.

Also, the extent to which existing transmission import limits could impact various resource procurement strategies has yet to be fully evaluated by CTPG or anyone else. Therefore, a more complete understanding of load serving entities' procurement plans or strategies is needed before a final state-wide transmission plan for California can be fully developed. In the interim, the CTPG has chosen to take a two step approach to developing a state-wide transmission plan. This two step approach will use publicly available information and combine that information with the results of studies performed by the CTPG in Phase 1 through Phase 4. This approach is intended to provide decision makers with potential transmission options for meeting at least a majority of the 33% RPS.

10.1 Step 1: Phase 3 High Potential Transmission Upgrades

Step 1, completed as part of the CTPG's Phase 3 work, consisted of the identification of the "high ranked" CREZs and the associated "high potential" transmission upgrades. This approach involved ranking CREZs using publicly available measures of commercial interest and then evaluating the relative amounts of power from the highest ranked CREZs that could be expected to flow on each of the transmission infrastructure additions identified in CTPG's Phase 1, Phase 2 and Phase 3 studies. The transmission infrastructure additions with the highest level of flow from these high ranked CREZs were deemed to be "high potential" transmission upgrades. The CTPG recognizes uncertainty exists in the development of the "high ranked" CREZs and, therefore, in the identification of the "high potential" transmission upgrades. These uncertainties include:

- Possible expiration of certain purchase power agreements (PPA) if renewable project development milestones required by the PPA's are not met
- Potential delays caused by environmental permitting challenges
- Increased environmental mitigation requirements that could affect the project economics and/or reduce the size of the proposed project
- Potential difficulties in obtaining financing

In Phase 3, the CTPG analysis concluded the initial set of associated "high potential" transmission elements could potentially provide transmission capacity to avoid reliability standard violations when renewable energy is being delivered to meet a California RPS of approximately 22% to 24% in year 2020 [43].

In the Phase 3 studies the assumed fossil generation redispatch has a significant impact on the ability of the transmission system to deliver renewable energy. The Phase 3 studies assumed that the output of fossil-fueled generation was decremented based on heat rate (as a proxy for relative operating costs) to achieve load-resource balance as the renewable resources were added to the resource dispatch. The results showed the proposed "high potential" transmission upgrades are insufficient, by themselves, to allow California to meet its 33% RPS goals without reliability criteria violations.

The amount of renewable power that can be generated without encountering reliability criteria violations is dependent upon the locations and amounts of fossil-fueled generation that is decremented. Accordingly, a different fossil-fueled generation decrement pattern based, for example, on eliminating reliability criteria violations rather than on economic merit, could increase the amounts of renewable power that can be produced without encountering reliability criteria violations. It should be understood that fossil generation decrementing patterns that are based only on eliminating reliability criteria violations may require the continued operation of coastal generation using OTC technologies and/or other relatively inefficient generation that could possibly be retired provided other infrastructure such as transmission and/or generation were constructed. Clearly, there are a number of variables such as state policy, cost, and/or environmental concerns that must be considered in determining the future disposition of older, fossil-fired generation. In addition, because it would typically take a number of hours to bring such inefficient generators from cold stand-by

[43] These studies have assumed that sufficient transmission infrastructure is in place to allow for the delivery of approximately 41,500 GWH of "existing" renewable resources

to full operation, they may need to be kept on-line and ready in anticipation of the criteria violation. There is a cost to employing a fossil-fired generation decrementing strategy that deviates from strict merit-order. Note that a different pattern of fossil fueled resource decrements might suggest a different set of high and medium potential transmission upgrades than the ones identified in CTPG's studies to date.

10.2 Step 2: Phase 4 High Potential Transmission Corridors

Step 2 consists of the identification of "high potential" transmission corridors and transmission upgrades within those corridors that may provide the State with options going forward in response to the uncertainty of the eventual locations of the renewable resources that will be procured by the state's LSEs. These options may prove useful in resolving key state policy decisions and rule makings. The Step 2 transmission upgrades are also offered as potential options for providing access by all of California's load serving entities to in-state and out-of-state renewable resources that the Step 1 upgrades do not facilitate. In addition these upgrades may be useful as alternatives to the proposed Step 1 upgrades if the development of one or more "high ranked" CREZs does not move forward as planned.

The identification of high potential transmission corridors in Step 2 is intended to help California's load serving entities determine which renewable resource projects and procurement strategies make the most sense considering that renewable resource projects outside of the areas considered in CTPG's Phase 1 , 2 and 3 studies may have less environmental restrictions and be less costly to develop. This could reduce total procurement costs, i.e., combined generation and transmission costs. CTPG believes that the construction of transmission upgrades within the high potential transmission corridors will help to sustain a competitive renewable resource development and procurement environment as final procurement decisions are made by the State's load serving entities. Finally, the CTPG believes that additional renewable resource options should be explored because California will have additional renewable resource needs *beyond* 2020.

The following criteria have been selected by the CTPG for identifying high potential transmission corridors. These corridors will be included in the 2010 CTPG State-Wide Transmission Plan and will be subject to consideration and further study in 2011. Selected high potential transmission corridors must meet a majority of the criteria listed below.

- ***Criteria No. 1 –*** The transmission corridor is associated with out-of-state transmission additions or upgrades currently being considered by other WECC planning entities for the delivery of renewable resources into California.

  This criteria was chosen by the CTPG because the entities that make up the WECC electric system should continue to work together to plan for and identify mutual solutions for satisfying respective renewable energy goals.

- ***Criteria No. 2 -*** The transmission corridor is associated with out-of-state transmission additions or upgrades that are known to be supported by federal and/or state government(s) for the purpose of developing and exporting renewable resources to California.

  This criteria was chosen by the CTPG because the success of completing out-of-state renewable energy projects and transmission infrastructure that may contribute to the potential export of renewable energy to California is contingent on the support of local and state governments.

- ***Criteria No. 3* –** The development of transmission additions or upgrades within the transmission corridor will facilitate a renewable resource portfolio for California that has geographical and weather (wind and sun) diversity.

  This criterion was chosen because of the advantages of renewable energy resources and associated transmission infrastructure not being in the same geographical and weather area. By having resources that are spread out, the state's renewable resource portfolio is less likely to be adversely impacted by unplanned electric system disturbances or by localized weather patterns.

- ***Criteria No. 4* –** The development of transmission additions or upgrades within the transmission corridor will support the delivery of energy to California from out-of-state entities that are either developing or planning for the development of renewable resources well beyond their own needs.

  This criterion was chosen to gauge the commitment of the regions outside of California to develop renewable energy resources beyond that required for these regions' own needs in order to export to California.

- ***Criteria No. 5* –** The development of transmission additions or upgrades within the transmission corridor will provide access to areas that have a successful record of renewable resource development.

  This criterion was chosen as a measure of the likelihood that the renewable energy projects being considered will actually be completed. This is a direct measure of whether proposed generation projects in a given region will be successful in obtaining interconnection and permitting approval and are also able to obtain financing.

It is expected that as critical legislative, policy and rule-making decisions are made, the high potential transmission corridors and transmission upgrades within those corridors will be adjusted and the results reflected in a more definitive state-wide transmission plan.

11 Results of High Potential Transmission Corridor Evaluation

11.1 Determination of High Potential Transmission Corridors

The CTPG utilized the data obtained from the survey of the out-of-state entities and the publicly available information described in Section 7 to compare three regions to the criteria described above in Section 9 to determine if there are any high potential transmission corridors, and transmission upgrades within those corridors, that should be recommended for further consideration by the CTPG and the BAA's going forward.

11.1.1 Pacific Northwest Corridor

In the Phase 3 studies, the CTPG identified the possibility of reliability criteria violations along the existing Pacific Northwest Corridor if significant renewable resources in the Pacific Northwest were procured by

California LSEs. The Phase 3 studies indentified transmission infrastructure additions in Northern California that would mitigate those violations. Transmission upgrades within the Pacific Northwest Corridor would consist of either an upgrade to the existing AC facilities located both north and south of the California-Oregon Border (COB) or an additional line added to the System both north and south of COB California currently imports significant amounts of existing energy resources through transmission interconnections in this existing corridor. The following includes an evaluation of the information provided in Section 7.1 above for entities within the Pacific Northwest Corridor to the CTPG criteria presented in Section 10. 2 above for consideration of the Pacific Northwest Corridor as a High Potential transmission corridor.

Criteria No.1 - The transmission corridor is associated with out-of-state transmission additions or upgrades currently being considered by other WECC planning entities for the delivery of renewable resources into California.

The Pacific Northwest Corridor meets this criterion. Potential additions within the Pacific Northwest Corridor are currently being studied by entities in the Pacific Northwest, British Columbia, and California and, based on study results to date, would be helpful in dealing with the BPA system impacts caused by the large amount of existing and planned variable renewable energy resources in the Pacific Northwest.

Criteria No.2 - The transmission corridor is associated with out-of-state transmission additions or upgrades that are known to be supported by federal and/or state government(s) for the purpose of developing and exporting renewable resources to California.

The Pacific Northwest Corridor meets this criterion. The existing and future development and potential export of renewable energy from the Pacific Northwest is well documented. Both BPA and the WAPA have the support of Congress in the financing and construction of new transmission infrastructure for the delivery of renewable energy resources throughout the WECC. The CTPG believes the strong federal support for transmission upgrades needed to deliver renewables throughout the west requires that CTPG work closely with these entities in CTPG's planning process and therefore should continue studying potential transmission upgrades to the Pacific Northwest corridors.

Criteria No.3 - The development of transmission additions or upgrades within the transmission corridor will facilitate a renewable resource portfolio for California that has geographical and weather (wind and sun) diversity.

The Pacific Northwest Corridor meets this criterion. Renewable energy resources imported from the Pacific Northwest would have a significant geographical distance and diversity from those identified in southern California. Therefore, transmission facilities required for delivery of renewable energy from these areas would be different and therefore independent of some types of transmission system disturbances that may expose the resources in southern California to curtailment. In addition, Pacific Northwest resources would likely provide weather diversity compared to the renewable resources being developed in southern California.

Criteria No.4 - The development of transmission additions or upgrades within the transmission corridor will support the delivery of energy to California from out-of-state entities that are either developing or planning for the development of renewable resources well beyond their own needs.

The Pacific Northwest Corridor meets this criterion. The Pacific Northwest development of wind resources is currently well beyond its own needs. In fact as discussed in Section 7.1, BPA has a considerable amount of wind today and expects to double its wind capacity by 2013. Nearly half of the wind is under contract to California entities. Because most of these contracts require BPA to accommodate the intermittency of the wind generators, BPA can experience operational problems, particularly during low load/high hydro periods when the amount of hydro capacity available to regulate the system is at low levels. BPA is trying to convince California regulators to endorse the improvements to the transmission system which would facilitate California load serving entities' ability to meet a portion of their RPS goals with intermittent renewable generation in the Pacific Northwest. The CTPG believes that continued study of the Pacific Northwest corridor may provide California with future options for obtaining cost-effective renewable energy.

Criteria No.5 - The development of transmission additions or upgrades within the transmission corridor will provide access to areas that have a successful record of renewable resource development.

The Pacific Northwest Corridor meets the criteria. Based upon the information provided in Section 7.1, the Pacific Northwest has significant experience developing wind resources. Based upon the information provided by BPA to the CPUC, at the present time and due to transmission limitations it may be necessary to curtail wind energy in the Pacific Northwest in order to minimize impacts on the operation of the hydro system in the area. Also in the Pacific Northwest, BPA has the encouragement of Congress to construct transmission facilities to deliver the renewable energy to other portions of the western United States. The Pacific Northwest track record of successful development of renewable energy resources justifies continued study of the potential delivery of these resources to California.

Based upon the Pacific Northwest Corridor meeting all of the above criteria, the CTPG recommends that the Pacific Northwest Corridor be designated a High Potential transmission corridor.

11.1.2 Northwest Nevada Corridor

The Northwest Nevada Corridor would consist of new and /or upgraded transmission facilities from Northwestern Nevada into Northern California. In the Phase 3 studies, the CTPG identified the possibility of reliability criteria violations if significant renewable resources are developed in Northeastern California and Northwestern Nevada and were procured by LSEs in California. The Phase 3 studies identified transmission infrastructure additions in the Northeast California region that would mitigate the identified violations. The following includes an evaluation of the information provided in Section 7.1 above for entities within the Northwest Nevada Corridor to the CTPG criteria presented in Section 10. 2 above for consideration of the Northwest Nevada Corridor as a High Potential transmission corridor.

Criteria No.1 - The transmission corridor is associated with out-of-state transmission additions or upgrades currently being considered by other WECC planning entities for the delivery of renewable resources into California.

The Northwest Nevada Corridor meets this criterion. The Northwest Nevada corridor has been studied by California entities and is currently being studied by the WestConnect Sierra Sub-regional Planning Group within its 2011 study process. These studies will include potential upgrades between Northern California and Northwest Nevada.

Criteria No.2 - The transmission corridor is associated with out-of-state transmission additions or upgrades that are known to be supported by federal and/or state government(s) for the purpose of developing and exporting renewable resources to California.

The Northwest Nevada Corridor meets this criterion. The development and potential export of renewable energy from northwest Nevada to California is strongly supported by the Nevada State Office of Energy. The state of Nevada believes that the development and export of Nevada renewable energy is extremely important to the state's economy. WAPA has the support of Congress in the financing and construction of new transmission infrastructure for the delivery of renewable energy resources throughout the WECC. In addition, this corridor would allow for renewables to be developed in the Lassen CREZ, which is currently constrained due to limited existing transmission capacity.

Criteria No.3 - The development of transmission additions or upgrades within the transmission corridor will facilitate a renewable resource portfolio for California that has geographical and weather (wind and sun) diversity.

The Northwest Nevada Corridor meets this criterion. Renewable energy resources imported from Northwest Nevada and Northeast California would have a significant geographical distance and diversity from those identified in southern California. Therefore, transmission facilities required for delivery of renewable energy from these areas would be different and therefore independent of some types of transmission system disturbances that may expose the resources in southern California to curtailment. In addition, the geographic diversity and resource diversity including the(addition of geothermal resources provides benefits in addition to those resources being developed in southern California.

Criteria No.4 - The development of transmission additions or upgrades within the transmission corridor will support the delivery of energy to California from out-of-state entities that are either developing or planning for the development of renewable resources well beyond their own needs.

The Northwest Nevada Corridor meets this criterion. The Northern Nevada queue is quite large when compared to the utility load in the area and the proposed 25%RPS by 2025. The state of Nevada is strongly supporting the development and export of renewable resources beyond its own RPS needs for economic benefits. In addition, this corridor would help increase the level of renewable resources (geothermal, solar, and wind) that could be developed in the Lassen CREZ, which is currently constrained due to limited existing transmission capacity..

Criteria No.5 - The development of transmission additions or upgrades within the transmission corridor will provide access to areas that have a successful record of renewable resource development.

The Northwest Nevada Corridor meets this criterion. Based upon the information provided in Section 7.1, the Northwest Nevada region has considerable success in developing geothermal and solar resources. In addition, this corridor would help increase the level of renewable resources (geothermal, solar, and wind)that could be developed in the Lassen CREZ, which as mentioned above is currently severely limited due to existing transmission capacity constraints.

Based upon the Northern Nevada Corridor meeting all of the above criteria, the CTPG recommends that the Northern Nevada Corridor be designated a High Potential transmission corridor.

11.1.3 Southwest Corridor-

In the Phase 4 studies, the CTPG identified the possibility of reliability criteria violations in southern California if significant renewable resources were procured by California LSEs and delivered through the state's interconnections with the desert southwest. The Southwest Corridor would consist of upgraded or new facilities between southern California and California's southwest electrical interconnections. The following includes an evaluation of the information provided in Section 7.2 above for entities within the Southwest Corridor to the CTPG criteria presented in Section 10. 2 above for consideration of the Southwest Corridor as a High Potential transmission corridor.

Criteria No.1 - The transmission corridor is associated with out-of-state transmission upgrades currently being considered by other WECC planning entities for the delivery of renewable resources into California..

The Southwest Corridor meets this criterion. The Southwest Corridor has been and will continue to be studied by the SWAT Subregional Planning Group in 2011.

Criteria No.2 - The transmission corridor is associated with out-of-state transmission upgrades that are known to be supported by federal and/or state government(s) for the purpose of developing and exporting renewable resources to California.

The Southwest Corridor meets this criterion. As described in Section 7.2 above. Nevada, Wyoming, Utah, Arizona, and New Mexico support the export of renewable energy to California and other states with RPS needs. These states consider the development or renewable energy resources and the export of the resultant renewable energy to be vital to their respective economies. WAPA has the support of Congress in the financing and construction of new transmission infrastructure for the delivery of renewable energy resources throughout the WECC.

Criteria No.3 - The development of transmission upgrades within the transmission corridor will facilitate a renewable resource portfolio for California that has geographical and weather (wind and sun) diversity.

The Southwest Corridor meets this criterion. Renewable energy resources imported from Wyoming, Montana, Idaho, Utah, Nevada, and New Mexico would have a significant geographical distance and diversity from those identified in southern California. Therefore, transmission facilities required for delivery of renewable energy from these areas would be different and therefore independent of some types of transmission system disturbances that may expose the resources in southern California to curtailment. In addition, the geographic diversity and resource diversity would provide benefits in addition to those resources being developed in southern California.

Criteria No.4 - The development of transmission upgrades within the transmission corridor will support the delivery of energy to California from out-of-state entities that are either developing or planning for the development of renewable resources well beyond their own needs.

The Southwest Corridor meets this criterion. Based upon the information provided in Section 7.2 above, Wyoming, Montana, Nevada, Utah, and New Mexico are each planning for the development and delivery of renewable resources far in excess of their respective RPS needs.

Criteria No.5 - The development of transmission upgrades within the transmission corridor will provide access to areas that have a successful record of renewable resource development.

The Southwest Corridor meets this criterion. Based upon the information provided in Section 7.2 above, Wyoming, Montana, Nevada, Utah, and New Mexico have had considerable success in developing renewable wind, solar, and geothermal resources

Based upon the Southwest Corridor meeting all of the above criteria, the CTPG recommends that the Southwest Corridor be designated a High Potential transmission corridor.

11.2 Conclusions and Recommendations

Based upon study results in Phase 3 and the further analysis performed in Phase 4, the Pacific Northwest Corridor the Northwest Nevada Corridor, and the Southwest Corridor warrant further study by the CTPG in 2011. These corridors are recognized as potential options for the state of California to import power, including renewable energy to meet the state's RPS goals. The corridors have been selected for the following reasons:

- The recognition by other sub-regional planning groups for study as potential WECC transmission system improvements
- The potential for geographic, weather, and resource diversity for California's renewable resource portfolio beyond that provided by renewable developed primarily in southern California,
- The strong support by federal and state governments required for the completion of the renewable resource projects and transmission improvements that would provide renewable energy throughout the western United States.
- Potential access to entities that are currently planning for the development or renewable energy resources well beyond their own needs for potential import into California.

12 Next Steps

12.1 Development of the CTPG 2010 Statewide Transmission Plan

12.2 CTPG 2011 Activities