2011 CTPG Draft Study Plan

July 15, 2011

TABLE OF CONTENTS

1 Introduction

The California Transmission Planning Group (CTPG) is a forum for conducting joint transmission planning studies consistent with Federal Energy Regulatory Commission (FERC) Order 890 principles and for coordinating CTPG members' transmission planning activities. The CTPG members include both transmission owners and operators who are subject to North American Electric Reliability Corporation (NERC)/Western Electricity Coordinating Council (WECC) transmission planning standards. The primary objective of CTPG has been to provide a foundation for a statewide transmission plan that identifies the transmission infrastructure needed to reliably meet California's 33% Renewable Portfolio Standard (RPS) goal by the year 2020.

An important qualification is that CTPG is not a transmission or generation project decision making body. The relevant CTPG members that are planning entities for their Balancing Authority Areas (BAA) will make such decisions. The statewide plan is intended to be conceptual rather than prescriptive, in keeping with CTPG's purpose. As such, the CTPG regularly requests and consolidates information on renewable projects from its members and state agencies to develop a likely snapshot of California's generation portfolio at some future time. This snapshot is then studied to identify regional transmission issues and propose potential transmission infrastructure additions that address those issues.

The CTPG, with the assistance of stakeholders in 2010, developed a California Transmission Plan (2010 Plan) for consideration by the state BAA's and other decision makers. For the 2011 Plan the CTPG will continue to review the appropriate categorization of the "high" and "medium" potential transmission upgrades identified in the 2010 Plan and determine if changes to this categorization are in order. The CTPG will determine if there are new renewable resource locations within or outside the state that have high development interest and whether study of different renewable resource development patterns is in order. If new resource development patterns emerge, the CTPG will determine if these patterns give rise to potential reliability criteria violations and, to the extent not previously identified, select new transmission infrastructure additions that mitigate those violations. The CTPG may also consider whether new patterns of renewable resource development would make previously detected reliability criteria violations unlikely, thereby eliminating the need for the associated mitigation.[1]

The 2011 Plan will be developed in three phases. Phase 1 will consist of developing detailed study assumptions used in the transmission planning studies. In Phase 2, transmission planning studies will be performed for the scenarios and assumptions documented in this study plan. The study results will be used to refine the determination of "high" and "medium" potential transmission upgrades. The 2011 Plan that emerges from Phase 3 will include any updates from the different BAAs on their respective transmission plans, lessons learned in 2011 and a proposed work plan for the 2012.

[1] To date, the only mitigation options evaluated by CTPG are transmission infrastructure additions.

2 Scenarios

CTPG recognizes the inherent uncertainty in any renewable generation portfolio described for 2020. For this reason, the CTPG will develop its 2011 Plan from the nine different scenarios described herein. These scenarios investigate the various means by which renewable resources will be made available to California load serving entities for purposes of meeting their 33% RPS requirement. Table 1 summarizes the renewable resources, season and pre-renewable path flow for each scenario. Other sections of this study plan provide more detailed information regarding the development of cases to model these scenarios.

Pacific Northwest Import

The Pacific Northwest Import scenario focuses on the impacts that the delivery of increased amounts of wind and hydro generation in the Pacific Northwest into California would have on the system south of the California-Oregon border. The wind generation to be modeled will include approximately 2,000 MW of existing and planned resources that are assumed to be "shaped" by small hydroelectric resources to provide an overall capacity factor of approximately 50%. The large hydro resources will be based on assumed higher utilization, close to 80% of installed capacity during high spring run-off conditions. This scenario represents a northern import alternative in contrast to other scenarios which assume the majority of new renewable resources are developed in southern California and/or the Desert Southwest. The Pacific Northwest Import scenario also includes a new discounted core and Renewable Energy Transmission Initiative (RETI) Best CREZ (Competitive Renewable Energy Zones) renewable resources located in California. Two scenarios will be examined with this import assumption, one will model stressed flows (north to south) on the California – Oregon Intertie (COI) and the other will utilize the foundation case. The foundation case uses the pre-renewable WECC generation dispatch pattern present in the WECC seed case; i.e., in the foundation cases selected paths are not "stressed" prior to adding the new renewable resources.

Northwest Nevada Import

The Northwest Nevada Import scenario focuses on the delivery of new wind, geothermal, and solar resources located in Northwest Nevada/Northeastern California assuming a summer peak load condition. This scenario represents another northern import alternative. It includes 750MW of geothermal generation to be modeled from Northwest Nevada and 200MW of wind along with 50MW of solar to be modeled from Northeast California. This scenario also includes a new discounted core and RETI Best CREZ renewable resources located in California. Two scenarios will be examined with this import assumption, one will model stressed flows (north to south) on the COI and the other will utilize the foundation case.

South to North Flow

The South to North Flow scenario will investigate potential reliability criteria violations during a fall morning with light load and high wind and morning solar generation in southern California. Paths 15 and 26 in central California will be flowing south to north at average historical fall morning values prior to the dispatch of the new renewable generation added to satisfy California's 33% RPS requirement. The South to North Flow scenario also includes a new discounted core and RETI Best CREZ renewable resources located in California. This scenario will be examined using the foundation case under fall conditions.

California Public Utilities Commission (CPUC) Public Policy Resource Portfolio

Incorporating updated assumptions for its 33% RPS Calculator model, the CPUC revised its "Cost Constrained" 33% RPS scenario from last year. The updated assumptions include an additional 1,384 MW of small-scale solar PV, and revisions to assumed transmission capabilities and costs in certain areas based largely on the CAISO Board-approved 2010/2011 Transmission Plan. The CPUC Public Policy Resource portfolio contains a total of 17,364 MW of newly installed renewable generating capacity. This includes 2,436 MW of distributed generation located within California and 4,337 MW of central station renewables located outside of California. The CPUC Public Policy Resource portfolio represents 54,269 GWh of new renewable energy sources. This portfolio will be scaled down to match the CEC staff's updated renewable net short of 46,974 GWh. As a modeling convenience, the CTPG is treating its estimate of impacts from the CPUC-approved distribution-level small-scale solar PV additions as a reduction to the CEC staff's updated renewable net short. This modeling results in a CTPG renewable net short of 45,131 GWh which is used in all of CTPG's scenarios.[2] This scenario will be examined using the foundation case under summer peak conditions.

Central California

The Westlands CREZ and central California have large areas of disturbed land where renewable development is expected to have low adverse environmental impact and therefore a higher likelihood of development. This scenario will use the existing California Independent System Operator (CAISO) queue for proposed resources in central California. These resources will include 4,916MW of solar thermal and photovoltaic resources, 130MW of wind resources, and 8MW of Bio resources. These amounts are based upon the assumption of an approximate 50% success rate of renewable development in central California. For modeling purposes renewable power will be injected at the Panoche, Gates and Midway substations. This scenario will be examined using the foundation case under summer peak conditions.

West of River (WOR) Import

The WOR Import scenario builds upon work completed by CTPG in 2010. It assumes a relatively high level of new renewable resources developed outside of California resulting in a large increase of energy that is delivered to California from southern Nevada and western Arizona. This scenario will test the import capability of the WOR transmission path during fall load conditions. Historically, flows on the WOR path peak during low load periods when lower cost energy is available for import into southern California. With low loads and high renewable imports, fossil-fired generation within California may be reduced relative to historical levels. WOR path flows will be set at the maximum level measured during the summer of 2010 with flows east to west prior to the addition of renewable resources. Two injection amounts will be

[2] The CPUC's net short estimate for year 2020 reflects renewable resource additions needed to meet California's 33% RPS requirement assuming (i) forecast retail loads included in the CEC's 2009 Integrated Energy Policy Report (IEPR), and (ii) renewable resources "existing" as of 2009. CTPG's net short estimate for year 2020 uses the CEC's staff's May 2011 load forecast update and renewable resources "existing" as of 12/31/2011.

examined; one scenario with injections at Eldorado (50% of the net short), Palo Verde (37.5% of the net short), and North Gila (12.5% of the net short) which will tend to stress the northern WOR system and another scenario with injections at Palo Verde (50% of the net short), Eldorado (37.5% of the net short), and North Gila (12.5% of the net short) which will tend to stress the southern WOR system.

Table 1: Scenarios

No.	Name	Description	Path Flow Pre-Renewables	Renewable Resources	Season Date Time	Net Short (TWH)
1	Pacific Northwest Import	Wind imports from Pacific Northwest combined with hydro runoff.	stress COI (n-s)	Out of State CPUC/POU discounted core RETI Best CREZs	spring (early June)	45.1
2			foundation*			
3	Northwest Nevada Import	Geothermal and solar from Nevada and wind from Northern California wih delivery to new substation and generation tie line.	stress COI (n-s)	Out of State CPUC/POU discounted core RETI Best CREZs	summer peak	45.1
4			foundation*			
5	South to North Flow	Determine transmission needs required during this time period generally characterized as light load with significant wind and morning solar generation. Paths 15 & 26 flows are south to north.	foundation*	Southern California CPUC/POU discounted core RETI Best CREZs	fall (Sep 9 AM)	45.1
6	CPUC Public Policy	Updates cost constrained scenario: includes Eldorado-Ivanpah, 1,384 MW of DG, 25% of 2020 RPS is out of state and projects from CAISO 2010/11 Transmission Plan.	foundation*	CPUC/POU discounted core CPUC Public Policy	summer peak	45.1
7	Central California	Large development of disturbed land with low enviromental impact. Inject power at Panoche, Gates and Midway.	foundation*	CPUC/POU discounted core Central California gen queue RETI Best CREZs	summer peak	45.1
8	West of River Import	High wind & solar imports from Wyoming, Utah, Nevada and Arizona to stress WOR. Inject power at Eldorado (50%), Palo Verde (37%) and N. Gila (13%).	stress WOR (e-w)	Out of State CPUC/POU discounted core RETI Best CREZs	fall (Sep 9 AM)	45.1
9		Same as Scenario 10, except inject power at Eldorado (37%), Palo Verde (50%) and N. Gila (13%).				

* The foundation cases use the pre-renewable WECC generation dispatch pattern present in the WECC seed case; i.e., in the foundation cases selected paths are not "stressed" prior to adding the new renewable resources.

3 Case Development

3.1 Overview

The CTPG obtained from WECC's case library the latest summer, spring and autumn cases to build the nine scenarios. These seed cases were selected as containing the most current detailed models of the entire WECC interconnected system with the appropriate seasons pertinent to this study. These cases are WECC full-loop representations and include the western United States, western Canada and the system of Comisión Federal de Electricidad (CFE) in Baja California, Mexico.

The following section provides the step-by-step verifications, updates and modifications of the WECC seed cases to create a scenario specific case for study. The creation of the seasonal, foundation and stressed path cases is the result of the completion of Step 0. The summer seed case is the basis for Scenarios 3, 4, 6 and 7. Scenarios 1 and 2 will be created from the spring seed case. The fall cases of Scenarios 5, 8 and 9 will be created from the light autumn seed case. Step 1 will model the renewables (generation and associated transmission) as required for each scenario. The renewable generation will be modeled at zero output. Step 2 completes the scenarios by dispatching the renewables. At the end of each step, a contingency analysis will be performed to determine if reliability criteria has been met.

Step 0: Develop Foundation & Stress Path Cases

- Verify and update existing renewable generation
- Model implementation plans of Once Through Cooling generation plants
- Verify and update all transmission projects which have Balancing Authority approvals
- Update to latest California Energy Commission 2020 load:
    - Summer peak
    - Spring
    - Fall
- Dispatch Paths:
    - Foundation - ensure all paths are within limits
    - Stress COI (n-s)
    - Stress WOR (e-w)
- Perform contingency analysis to confirm reliability criteria is met

Step 1: Add Renewable Projects

- Model renewable projects, generation and associated transmission such as gen-ties and collector systems, as required by scenario
- Renewable generation modeled at 0 MW output
- Perform contingency analysis to confirm reliability criteria is met

Step 2: Dispatch Renewables

- Dispatch renewable projects to anticipated output for each scenario
- Decrease fossil generation to balance renewable increase
- Perform contingency analysis to confirm reliability criteria is met
- Where reliability criteria violations are found, identify transmission infrastructure additions that mitigate the violations

3.2 Load Forecast

Table 2 shows the 2020 summer peak, spring and fall forecasts modeled in the scenarios. The summer peak assumes a northern California 1-in-10 year peak demand coincident with a southern California 1-in-2 year peak demand. The spring and fall conditions are modeled at approximate 65% of summer peak. Starting with the CEC staff's May 2011 forecast peak demands which includes incremental energy efficiency, incremental Combined Heat and Power

(CHP), and other incremental behind-the-load-meter distributed generation (e.g., rooftop solar PV additions), the peak demand was reduced by:

- pump loads
- the projected impact of existing in-front-of-the-load-meter distributed generation (e.g., digester and landfill gas, small hydro, wholesale PV and other small capacity generation)[3]
- the assumed impact from the Investor Owned Utilities' CPUC approved in-front-of-the-load-meter solar PV programs
- forecast transmission losses (since the power flow program determines transmission losses based on the simulated power flows)

Table 2: 2020 Demand (MW) Based On CEC May 2011 Forecast

AREA		SUMMER PEAK (MW)				SPRING & FALL (MW)			
NO.	NAME	LOAD	PUMPS	LOSSES	TOTAL	LOAD	PUMPS	LOSSES	TOTAL
30	PG&E*	31,127	256	1,073	32,456	19,235	443	720	20,398
24	SCE	25,980	191	437	26,608	16,176	1,069	294	17,539
22	SDG&E	4,975	-	76	5,051	3,671		58	3,729
26	LADWP	6,750	-	378	7,128	5,417		385	5,802
21	IID	1,293	-	55	1,348	1,010		40	1,050
Total		70,125	447	2,019	72,591	45,509	1,512	1,497	48,518

* Includes SMUD & TID

3.3 Planned Transmission Projects

All scenarios will include transmission projects that have been approved by their applicable Balancing Authority. A list of the significant transmission projects included in the nine scenarios is provided in Table 3.

Table 3: Balancing Authority Approved Transmission Projects

Project Name	Area:
COI 4800 Project	BPA
Little Goose Reinforcement Project	
West of McNary Reinforcement Project	
I-5 Corridor Reinforcement Project	
Imperial Valley-Dixieland 230 kV line	IID
Coachella Valley Substation to Mirage Substation (Path 42) double circuit 230 kV line reconductoring. (Path 42 Upgrade 1600 MW).	
El Centro Switching Station (ECSS) to Highline Station double circuit 230 kV transmission project.	
IV Sub to IID IV Sub and IID IV Sub to ECSS 230 kV transmission project.	
Path 42 upgrade to 800 MW	
Encina - Penasquitos 230 kV #2	SDG&E
Sunrise Powerlink	
HLSP1, HLSP2	LADWP
BCON18G	
SODMTGEN	
Barren Ridge - Haskell 230 kV (Barren Ridge Renewable Transmission Project Phase I)	
Barren Ridge - Rinaldi 230 kV upgrade (Barren Ridge Renewable Transmiission Project Phase II)	

[3] The impacts of behind-the-load-meter distributed generation are reflected in the forecast loads modeled in the power flow program.

Project Name	Area:
Eldorado-Ivanpah Transmission Project (EITP)	SCE
Red Bluff Substation 500/230kV	
New Pisgah 500kV Sub, New Lugo-Pisgah 500kV T/L, Loop existing Eldorado-Lugo 500kV T/L	
Devers - Mirage 115 kV system Split	
Devers - Coachella valley 230 kV line loop	
San Joaquin Cross Loop	
Devers - Palo Verde 500 kV Transmission Line (DPV2)	
Rancho Vista 500/230 kV substation	
Mira Loma 500 kV shunt Capacitors	
Wildlife (formerly Jurupa) 230 kV substation	
Third A-Bank and rebuild of the 115 kV switch Rack at Victor Substation Phase 1	
Tehachapi Renewable Transmission Project	
Inland Empire Energy Center	
NRG El Segundo	
EME Walnut Creek	
Blythe Energy I Project	
T1058: San Benito Transmission Work (was San Justo Substation Interconnection)	PG&E
T1177: Natividad Substation Installation	
T970A: Crazy Horse Switching Station	
T1005: Sanger – Reedley 70 kV to 115 kV Conversion	
T854: Metcalf – Evergreen 115 kV	
T1173: Santa Cruz 115 kV Reinforcement	
T1003: Herndon 230/115 kV Transformer	
T1196: Morro Bay 230/115 kV Transformer Addition Project	
T1091: Tri-Valley Voltage Control	
T994: Lakeville – Ignacio #2 230 kV Line	
T258A: Gregg 230 kV Reactor	
T1120: Shepherd Substation Interconnection	
T759C: Atlantic – Lincoln Transmission	
T1042: Sanger – California Ave 70 kV to 115 kV Conversion	
T947: Hollister 115 kV Reconducting	
T984: Pittsburg – Tesla 230 kV Reconducting	
T1195: Ashlan-Gregg and Ashlan-Herndon 230 kV Line Reconductor	
T991: Contra Costa – Moraga 230 kV Line Reconductoring	
T1090: Midway – Renfro 115 kV Line Reconductor	
T1182: Mountain View/Whisman–Monta Vista 115 kV Reconductoring	
T982: Newark – Ravenswood 230 kV Line	
T197B: Ignacio – San Rafael and Ignacio – Las Gallinas 115 kV Reconductoring	
T986: Woodward 115 kV Reinforcement	
T444C: Missouri Flat – Gold Hill 115 kV Line	
T686A : Palermo – Rio Oso 115 kV Line Reconductoring	
T1040: Ravenswood – Cooley Landing 115 kV Reconductor	
T920A: South of San Mateo Capacity Increase	
T967: Tesla 115 kV Capacity Increase	
T249: Bay Meadows 115 kV Reconductoring	
T444D: Gold Hill - Horseshoe 115 kV Reinforcement	
T603B: Vaca Dixon-Lakeville 230 kV Reconductoring	
T1055: Stone Substation Capacity Increase	
T1127: Evergreen - Mabury 60 kV to 115 kV Conversion	
T1092: Occidental of Elk Hills 230 kV Interconnection	
T990: Moraga Transformer Capacity Increase	
T985B: Rio Oso 230/115 kV Transformer Upgrades	
T1214: Pit 3 - Pit 1 and Pit 3 - Round Mountain 230 kV Line Relays Replacement	
T1030: Table Mountain – Rio Oso 230 kV Reconductor and Tower Raises	

3.4 Existing Renewable Generation

The objective of this effort was to assure that the WECC seed cases used for the CTPG 2011 studies accurately modeled the types, amounts and locations of existing renewable energy resources located within California or directly interconnected with the California grid that were in-service as of December 31, 2010. A summary of such existing renewable generation in-service by resource type obtained from CEC draft QFER data as of early-April 2011 is provided in Table 4. With the assistance of the CTPG membership, the WECC seed cases were reviewed to identify which of the various units/plants were explicitly modeled in the seed cases and which were "load netted" and to determine if there were units/plants listed in the CEC data that needed to be added to the seed cases. The data obtained from this review was used to prepare change files to update the 2020 seed cases to include those units/plants that should be explicitly modeled.

Table 4: Existing In-State Renewable Generation as Of December 2010

Resource Type	Capacity (MW)	2010 Energy (TWH)	No. of Units/ Plants
Interconnected With California Grid			
Biomass	1,025	5.65	121
Geothermal	2,687	13.11	68
Small Hydro	1,169	4.18	210
Solar	429	0.91	21
Wind [4]	3,019	4.80	96
Total	8,329	28.65	516
Interconnected With Other Systems			
Biomass	20	0.04	1
Small Hydro	65	0.25	5
Total	85	0.29	6
Total Existing Renewables			
Biomass	1,045	5.69	122
Geothermal	2,687	13.11	68
Small Hydro	1,234	4.43	215
Solar	429	0.91	21
Wind	3,019	4.80	96
Total	8,414	28.94	522

The data in Table 4 indicates that, on an annual basis, the capacity factor for the existing wind generation would be approximately 18% which would be expected if the entire amount of wind capacity was not in-service for the entire year. Review of the CEC QFER data indicates that approximately 840 MW of wind generation (approximately 28% of the total amount in service at the end of 2010) was added during the year. If it was assumed that the full 3,019 MW of wind capacity had been in-service for all of 2010 and that the annual capacity factor of the installed wind generation was 30%, the total wind generation during the year would have been approximately 7.9 GWH (an increase of about 3.1 GWH from the amount in Table 4). As a result, the total energy in Table 4 would increase to approximately 32 TWH.

[4] CEC data did not include information as to the number of wind plants in service as of the end of 2010

In addition to the above existing in-state renewable generation, CEC reports indicate that in 2009 approximately 5.8 TWh of renewable generation utilized within California was located out-of-state. However, because no detail has been provided as to the location of these resources, the CTPG cannot, at this time, verify the existence of these facilities in the 2020 seed cases. Verifying that these facilities are modeled in the 2020 seed cases throughout the entire WECC would be a significant effort. The CTPG believes that, due to the accuracy of modeling of in-state resources, it is likely the out-of-state resources are also in the seed cases. Regardless, the CTPG 2011 Net Short accounted for these resources.

Also, in addition to the in-state and out-of-state renewable resources, the CEC identified approximately 4.6 TWh of renewable generation that is expected to be in-service by the end of 2011. The CTPG could not verify that all of these facilities were modeled in the base case. However, the CTPG believes that these facilities are also likely in the seed cases due to the accuracy of the modeled facilities prior to 2010. In the event the facilities expected to be completed this year are not currently modeled in the seed cases, it is expected these facilities will likely be inserted with the inclusion of the CPUC/POU discounted core since the core resources most accurately reflects the procurement plans of the state as of 2010.

Table 5 presents information regarding the capacity, annual energy, and number of units/plants by resource type which were identified as being explicitly modeled in the base cases (and interconnected with the California grid) or which were identified as being netted against the load at the pertinent high voltage busses.

Table 5 – Summary of Modeled and Load Netted Resources

Resource Type	Modeled Units			"Load Netted" Units		
	Capacity (MW)	2010 Energy (TWH)	No. of Units/ Plants	Capacity (MW)	2010 Energy (TWH)	No. of Units/ Plants
Biomass	846	4.73	50	179	0.92	71
Small Hydro	906	3.28	122	263	0.90	88
Solar	406	0.89	10	23	0.02	11
Total	2,158	8.90	182	465	1.84	170

As shown in Table 5, the total number of explicitly modeled biomass, small hydro, and solar units interconnected with the California grid is only slightly larger than the number of facilities that are load-netted. However, approximately 82% of the total capacity associated with the biomass, small hydro, and solar plants/units that are interconnected with the California grid is explicitly modeled in the base cases.

Table 6 presents information regarding the number and associated installed capacity of units/plants that were added to the two WECC seed cases as a result of the effort discussed above.

Table 6 – Summary of Units Added to Seed Cases

Resource Type	Summer Case		Spring Case	
	Number of Units Added	Capacity Added MW)	Number of Units Added	Capacity Added MW)
Biomass	0	0	0	0
Geothermal	0	0	0	0
Small Hydro [5]	5	13	5	13
Solar [6]	1	5	1	5
Wind [7]	0	0	5	103
Total	6	18	11	121

When the small hydro and solar units were added to the data sets their status was set to "1" such that they were modeled as being on-line. However, the status of the wind units was set to "0" so as to match the "off-line" status of a majority of the existing wind units in the data sets.

Table 7 presents information comparing the capacity and number of units/plants by resource type interconnected to the California grid as presented in the CEC data to what was modeled in the seed cases after being modified to include the units shown in Table 6.

Table 7 – Comparison of CEC Data and "As Modeled" Data

Resource Type	Per CEC Data		In Data Sets	
	Capacity (MW)	N0. of Units/ Plants	Capacity (MW)	N0. of Units
"Modeled" Units				
Biomass	846	50	837	48
Geothermal	2,687	68	2,764	58
Small Hydro	906	122	941	103
Solar	406	10	390	10
Wind	3,019	96	3,024	96
Subtotal	7,864	346	7,956	315
"Load Netted" Units				
Biomass	179	71		
Small Hydro	263	88		
Solar	23	11		
Subtotal	465	170		
Total	8,329	516		

[5] Units added to LADWP system in Owens Gorge area
[6] "Cal-Renew" unit added to PG&E system
[7] Hatchet Ridge project units added in spring case

As shown in Table 7 there are some differences between the number of units/plants contained in the CEC list to the number of units explicitly modeled in the seed cases. These differences are due to how various units/plants were "aggregated" in the CEC data compared to how they are modeled in the powerflow data. In addition, as shown in Table 7, the installed capacity of the "modeled" units in the powerflow data sets is about 90 MW (1.2%) higher than the capacity values from the CEC data. It is the CTPG's opinion that the modeling of the existing renewables (both with respect to the number of units and installed capacity) in the modified seed cases accurately reflects the information in the CEC data.

Review of the two seed cases (modified to add the resources summarized in Table 6) also indicated that a number of the existing renewable units/plants modeled as "off-line". Table 8 summarizes these findings for the two cases. Review of the information in Table 8 indicates that in the "final" seed cases, the status of a number of units (particularly wind) will need to be changed so that these units are on-line in subsequent studies. The capacity modeled for these units (plus those already on-line) will also need to be adjusted, as appropriate, to be reflective of the seasonal/time-of-day conditions modeled in each of the various Scenarios discussed above.

Table 8 – Comparison of Total Units to "On-Line" Units

	Summer Case		Spring Case	
	Total No. of Units	No. of On-line Units	Total No. of Units	No. of On-line Units
Biomass	48	44	48	43
Geothermal	58	56	58	54
Small Hydro	103	86	103	80
Solar	10	10	10	10
Wind	96	43	96	9
Total	315	239	315	196

3.5 Fossil Generation Updates

The WECC seed cases were updated to reflect current information regarding the status of fossil generation units. The following fossil plants were added to the seed cases to reflect recently awarded power purchase agreements (PPAs).

PG&E Area:
Marsh Landing, 774 MW by 2013
Oakley, 672 MW by 2016
Mariposa, 200 MW by 2013
GWF Tracy Expansion, 150 MW addition by 2012
Los Esteros Expansion, 120 MW addition by 2013

SDG&E Area:
Pio Pico (304.8 MW) (LMS100)
Escondido Energy Center (repower an old gas turbine) (45 MW) (LM6000)
Quail Brush ("Cogentrix") (99.8 MW) (gas-fired Wartsilla reciprocating engines)

3.6 Once Through Cooling (OTC)

On May 4, 2010, the State Water Resources Control Board adopted a Statewide Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling under Resolution No. 2010-0020. Plant owners/operators were required to submit implementation plans on April 1, 2011 to the Statewide Advisory Committee on Cooling Water Intake Structures. Where possible the CTPG will use information from the public implementation plans. Three of the 17 OTC plants have shut down or re-powered. The remaining 14 plants submitted implementation plans. Diablo Canyon and San Onofre will be modeled as base loaded.

Compliance options:

1. Retirement by compliance deadline.
2. Track 1 – Units are re-powered or retrofitted with closed cycle wet or dry cooling to decrease water inflow rate.
3. Track 2 – Comparable reduction in impingement mortality and entrainment using operational or structural measures. Must demonstrate Track 1 is not feasible.

Immediate and interim requirements must also be addressed with large organism exclusion devices and cease water intake on non-power generating units unless need is demonstrated.

The CTPG will review the need for generation within local areas in order to meet applicable local capacity requirements such as CAISO's "2013-2015 Local Capacity Technical Analysis, Report and Study Results" and similar studies made available by other Balancing Authorities. CTPG will assume OTC units are either repowered with efficient combined cycle technology, or with the newer generation of gas turbines, to meet local reliability requirements. No uncommitted transmission projects will be included. Adequate system support should be provided by following the local capacity requirements.

Based on the review of the implementation plans submitted by generator owners, the CTPG will be using the following guidelines for modeling the OTC units within the CTPG base cases.

If the implementation plan specifies:

1. Retirement by 2020, the unit will be retired.
2. Track 2 Compliance by 2020, the unit will remain unchanged.
3. Track 1 Compliance by 2020 and only changing cooling system, the unit will remain unchanged.
4. Track 1 Compliance by 2020 with new generator type and size, the unit will be modeled as stated.
5. Track 1 Compliance with an unstated generator type, but size or minimum MW known, the unit(s) will be modeled according to the following table:

Generic Power Flow Assumptions		
GE LM6000	Simple Cycle	50 MW
GE LMS100	Simple Cycle	100 MW

GE Frame 7	CC 2x1	500 MW	(140 MW, 140 MW, 220 MW)

*Start by assuming the largest generator and number of generators to reach target. If excess capacity is greater than 50 MW, reduce by 1 generator, proceed to next largest generator type, and repeat. Reduce the generation output pro-rata by the excess capacity amount

Ex. 946 MW:	2 x 500 MW	1000	54 MW > 50 MW
	1 x 500 MW	500	
	5 x 100 MW	1000	54 MW > 50 MW
	1 x 500 MW	500	
	4 X 100 MW	900	
	1 X 50 MW	950	4 MW < 50 MW

6. Track 1 or Track 2 compliance, Track 1 assumptions will be used.
7. Track 1 or Retirement, Retirement will be assumed.
8. Two or more capacity options, the lower of the two will be used. Excess capacity will be reduced on a pro-rata basis.

Pro-Rata Reduction	Max	Output	Approximate Representation
	500	497.89	497
	100	99.58	100
	100	99.58	100
	100	99.58	100
	100	99.58	100
	50	49.79	49
	950	946	946

GE machines will be used for generic power flow and dynamic response assumptions due to availability of models and information in the General Electric Positive Sequence Load Flow program (GE-PSLF). The capacity value assumptions were chosen for simplicity, consistency, and closeness to typical outputs of similar machines currently. Where specific machine information is made available, the CTPG will use that data instead of generic assumptions.

The following tables list the changes made to the OTC units by utility.

Table 9 - PG& E OTC Units

		2020 HS Case/ Plant Owners	Plant Owners		SWRB	CTPG Assumptions			
Generating Station	Units	Existing Capacity (MW)	Compliance Option	Implementation Timeline (Beyond Compliance Deadline)	Compliance Deadline	Area	Powerflow Model Changes	Modified Capacity (MW)	Units Modeled and Capacity
Humboldt Bay Power Plant	1-10	166	n/a	Complete		PG&E	n/a		No Change
Morro Bay Power Plant	1-4	650	Track 2	By Dec 31, 2015	12/31/2015	PG&E	Repower 164 MW	164	164
Moss Landing	1-2	1,020	Track 2	Compliance through 2032	12/31/2017	PG&E	No Change		No Change
Power Plant	6-7	1,509	Track 2	By Dec 31, 2017	12/31/2017	PG&E	Repower 100 MW	100	100
Pittsburg	5-6	660	Track 1	By Dec 31, 2017	12/31/2017	PG&E	No Change		No Change
Generating	7	740	Retirement	2016	12/31/2017	PG&E	Retired	0	0
Potrero Generating Station	3	0	Retired	February 28, 2011		PG&E	Retired	0	0

Table 10 - LADWP OTC Units

		2020 HS Case/ Plant Owners	Plant Owners		SWRB	CTPG Assumptions			
Generating Station	Units	Existing Capacity (MW)	Compliance Option	Implementation Timeline (Beyond Compliance Deadline)	Compliance Deadline	Area	Powerflow Model Changes	Modified Capacity (MW)	Units Modeled and Capacity
Harbor Generating Station	5	65	Track 1	2031	12/31/2015	LADWP	No Change; Transition Begins after 2020	65	No Change
Haynes Generating Station	5-6	535	Track 1	2013	12/31/2015	LADWP	No Change; 6 SC, 6x100 MW already modeled in 2020 HS case	600	No Change
	1-2	444	Track 1	2027	12/31/2015	LADWP	No Change; Transition Begins after 2020	444	No Change
	8	235	Track 1	2035	12/31/2015	LADWP	No Change; Transition Begins after 2020	250	No Change
Scattergood Generating Station	3	460	Track 1	2015	12/31/2020	LADWP	1 CC - 310 MW, 2 SC - 200 MW; Representation as specified by LADWP	510	510
	1-2	367	Track 1	2024	12/31/2020	LADWP	No Change; Transition Modeled in 2020 HS case	367	No Change

Table 11 - SCE OTC Units

		2020 HS Case/ Plant Owners	Plant Owners		SWRB	CTPG Assumptions			
Generating Station	Units	Existing Capacity (MW)	Compliance Option	Implementation Timeline (Beyond Compliance Deadline)	Compliance Deadline	Area	Powerflow Model Changes	Modified Capacity (MW)	Units Modeled and Capacity
AES Alamitos Generating Station	1-6	2,010	Track 1	Some Units Beyond Dec 31, 2020	12/31/2020	SCE	2 CC (500), 4 SC (100), 1 LM6000 (50)	1417	98 98 98 98 489 489 47
AES Huntington Beach Generating Station	1-4	900	Track 1	Some Units Beyond Dec 31, 2020	12/31/2020	SCE	1 CC (500), 3 SC (100)	800	500 100 100 100
AES Redondo Beach Generating Station	5-8	1,356	Track 1	Some Units Beyond Dec 31, 2020	12/31/2020	SCE	1 CC (500), 4 SC (100), 1 LM6000 (50)	946	100 100 100 100 497 49
El Segundo Generating Station	1-2	0	Track 1	2013	12/31/2015	SCE	1 CC, 560 MW	560	157 157 246
	3	335	Retirement	2013	12/31/2015	SCE	Retired	0	0
	4	335	Track 1	Retired by 2017 if unable to repower	12/31/2015	SCE	Retired	0	0
Mandalay Generating Station	1-2	430	Track 2	Prior to Dec 31, 2020	12/31/2020	SCE	No Change	430	No Change
Ormond Beach Generating Station	1-2	1,520	Track 2	Prior to Dec 31, 2020	12/31/2020	SCE	No Change	1500	No Change

Table 12 - SDG&E OTC Units

		2020 HS Case/ Plant Owners	Plant Owners		SWRB	CTPG Assumptions			
Generating Station	Units	Existing Capacity (MW)	Compliance Option	Implementation Timeline (Beyond Compliance Deadline)	Compliance Deadline	Area	Powerflow Model Changes	Modified Capacity (MW)	Units Modeled and Capacity
Contra Costa Generating Station	6-7	690	Retirement	2013	12/31/2017	SDG&E	Retired	0	0
Encina Power Station	1	107	Track 1	2017	12/31/2017	SDG&E	1 CC, 558 MW	558	156
	2	104				SDG&E			156
	3	110				SDG&E			246
	4-5	630	Track 2	2017	12/31/2017	SDG&E	No Change	628	No Change
South Bay Power Plant	1-4	0	Retired	-	12/31/2012	SDG&E	Retired	0	0

3.7 Transmission Path Flows

Tables 13 provide the target flows to stress particular paths for several scenarios. The left side of Table 13 lists the WECC path number, name and the megawatt (MW) ratings of the path. Several paths have two ratings, a north to south (n-s) and a south to north (s-n) rating. The WOR path is only rated in the east to west (e-w) direction. The right side of the table show the path flow targets for the stress path cases prior to the addition of renewable resources. The COI will stress Paths 66 and 65 to rated levels for Scenarios 1 & 3. The WOR will target a flow of

7,250 MW which was the maximum flow measured during the summer of 2010. The WOR stress will be modeled for Scenarios 8 & 9. The scenarios may not be able to fully achieve these targets due to various reasons: resources at the sending end of the path are either insufficient and/or turn-down capability of generation at the receiving end is limited by local area constraints. CTPG members responsible for these scenarios will attempt to hit the target flows shown in Table 13 but, if unable, will document and explain any shortfall.

Representative megawatt levels of the major paths in California for the three foundation cases are listed in Table 14. These path flows approximate where flows may be prior to the addition of renewable generation. Ultimately, load levels and the particular generation dispatch pattern of the WECC seed case will dictate path flows. CTPG will not attempt to move paths to any particular value to form the foundation cases. Table 14 simply provides a gauge of the WECC seed cases.

Table 13: Stress Path Target Flows (MW) Pre-Renewables

WECC Path						Stress Path Cases			
No.	Name	Rating				COI		WOR	
		MW	Dir.	MW	Dir.	MW	Dir.	MW	Dir.
66	California - Oregon Intertie (COI)	4,800	n-s	3,675	s-n	4,800	n-s	-	-
65	Pacific DC Intertie (PDCI)	3,100	n-s	3,100	s-n	3,100	n-s	-	-
46	West of Colorado River (WOR)	10,623	e-w	-	-	-	-	7,250	e-w

Table 14: Foundation Path Flows (MW) Pre-Renewables

WECC Path						Foundation Cases					
No.	Name	Rating				Fall		Summer		Spring	
		MW	Dir.	MW	Dir.	MW	Dir.	MW	Dir.	MW	Dir.
66	California - Oregon Intertie (COI)	4,800	n-s	3,675	s-n	1,900	s-n	3,800	n-s	3,700	n-s
15	Midway - Los Banos	3,265	n-s	5,400	s-n	3,500	s-n	1,600	s-n	900	n-s
26	Northern - Southern California	4,000	n-s	3,000	s-n	400	s-n	900	n-s	3,300	n-s
65	Pacific DC Intertie (PDCI)	3,100	n-s	3,100	s-n	2,000	s-n	2,600	n-s	2,600	n-s
27	Intermountain Power Project (IPP) DC Line	2,400	ne-sw	1,400	sw-ne	1,800	ne-sw	2,300	ne-sw	1,000	ne-sw
46	West of Colorado River (WOR)	10,623	e-w	-	-	4,900	e-w	2,100	e-w	4,000	e-w
49	East of Colorado River (EOR)	9,300	e-w	-	-	3,600	e-w	2,100	e-w	4,600	e-w
	Southern California Import Transmission (SCIT)	-	-	-	-	5,000		9,000		12,000	

4 Study Guideline and Reliability Criteria

The CTPG will conduct contingency-based power flow analysis for the scenarios described in Section 2. The GE-PSLF will be used in conjunction with in-house Engineer Programming Control Language (EPCL) routines to analyze the study results. The study will use the following study methodology and criteria:

1. In the pre-contingency state and with all facilities in-service, the Bulk Electric System (BES) shall demonstrate transient, dynamic, and voltage stability. Facility ratings shall not be exceeded and uncontrolled separation shall not occur.

2. Starting with all facilities in-service and following single and double contingencies, the BES shall demonstrate transient, dynamic, and voltage stability. Facility ratings shall not be exceeded and uncontrolled separation shall not occur.
3. The single contingency analysis shall meet requirements R2.2 and R2.3 of NERC Reliability Standard FAC-010-2.1.
4. The double contingency analysis shall meet the requirements R2.5 and R2.6 and Regional Differences E.1 of FAC-010-2.1.

NERC Standard FAC-010-2.1 (E.1.2.5) provides that for double contingencies, the controlled interruption of electric supply (load shedding), the planned removal of certain generators (generation dropping), and/or the curtailment of firm power transfers may be necessary to maintain the overall security of the interconnected transmission system. These system adjustments can be made either manually or automatically via protection control systems. The CTPG will not be performing an alternative analysis for mitigating the need for a new or upgraded transmission line with protection control systems. This alternative analysis will be completed by the entity responsible for each particular proposed transmission improvement utilizing its own analysis assumptions and mitigation policies and practices.

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

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 (FAC-010 E1.1.6) 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 (FAC-010 E1.1.7).

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 and WECC standards provide a framework from which computer simulation studies will be performed to model forecasted system conditions and evaluate system performance. The following standards will be used, along with FAC-010, for the 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
   - TPL–(001-004)–WECC–1–CR: System Performance Criteria

- o 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

The NERC Standards TPL-001 through -003 requires that the transmission system be "planned such that the Network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services, at all demand levels over the range of forecast system demands". The CTPG will address the potential violations of NERC/WECC reliability standards at the network level only. Potential violation at the local load center level will be reported in the study and addressed by the entity responsible for local load center reliability.

CTPG will perform dynamic studies in 2011. Dynamic models for existing facilities will not be altered from the WECC seed case. Generic models will be used for the additional renewable resources required in 2020.

5 2020 Renewable Energy Planning Target (Net Short)

The CTPG updated the amount of renewable energy resource additions, "net short", that will be required between 2011 and 2020 to meet the 33% RPS requirement for the state of California. Net short updates are being considered in the development of the CEC's 2011 Integrated Energy Policy Report with energy efficiency, CHP and distributed photovoltaic as key variables. The CEC staff's May 2011 forecast update includes a range of forecasts ("Updated Low", "Updated Mid" and "Updated High") and, correspondingly, a range of renewable net shorts. As detailed on Table 5, CTPG will utilize the "High" net short estimate for all scenarios.

Table 15: 2020 CTPG Net Short (CEC "Updated High")

GWH	
305,256	**2020 CEC Energy Demand Forecast (May 2011)**
	Energy not subject to RPS
3,320	Central Valley Project Pump Load
1,507	Metropolitan Water District Pump Load
8,729	Department of Water Resources Pump Load
15,200	Energy Efficiency
2,336	Private Photovaltaic
-	Combined Heat and Power
274,164	**Retail sales subject to RPS**
90,474	**Renewable Generation Requirement (33%)**
43,500	Existing Renewables
46,974	**CEC Staff Renewable Net Short**
	CPUC Approved Solar PV Program
876	SCE
91	SDG&E
876	PG&E
45,131	**CTPG Renewable Net Short**

6 Renewable Generation Dispatch

All scenarios will include the CPUC discounted core, currently being considered as part of the CPUC Long Term Procurement Plan. The criteria that staff proposes be used to determine inclusion in the discounted core is:

1.) A project must have a signed power purchase agreement (PPA) either under review or already approved by the Commission as of June 1, 2010; and

2.) The project must have its major permit (Application for Certification if under the jurisdiction of the Energy Commission; Conditional Use Permit in most other cases) filed with and deemed data adequate by the appropriate agency, as of March 1, 2010

The discounted core includes renewable resources located in Alberta, Oregon, Idaho, Montana, New Mexico, southern Nevada and Arizona. The CTPG has modified the CPUC discounted core with the following changes and will refer to it as the CPUC/POU discounted core:

- Removed Round Mountain CREZ 78MW. The proposed renewable resource project was completed this year and is modeled in the seed case
- Moved San Diego South CREZ 21MW to Non-CREZ. This proposed bio resource was incorrectly listed as a San Diego South CREZ resource
- Added 128MW Wind to the Solano CREZ. This project is a POU project under construction.

The CPUC/POU discounted core includes 25,138 GWh of resources; the remaining energy need by the studies to provide for the net short will consist of resources identified by the Renewable Energy Transmission Initiative in their Phase 2B report as RETI's Best California CREZs. A summary of the renewable resources for each scenario is provided in Table 16. A breakdown by CREZ of the CPUC/POU discounted core is provided in Table 17 and Tables 18 through 24 details the renewable energy and dispatch by CREZ for each scenario.

CTPG will use generic factors to relate nameplate capacity to expected renewable energy production for the hour of study (e.g., peak hour, off-peak hour). These generic factors will be obtained from the monthly/hourly technology-specific energy output profiles prepared for each CREZ and renewable resource development area that correspond to the hour and month that will be simulated in the power flow program. The monthly/hourly technology-specific energy output profiles are based on actual hourly output data for similar technologies in similar locations or on studies of technical resource potential (e.g., solar insolation, wind speeds, subsurface steam availability, biomass fuel availability, terrain limitations, and land use limitations) in different areas of the WECC.[8] This energy spreadsheet was developed for the CPUC and requires a time adjustment from Greenwich Mean Time to Pacific Standard Time.

All renewable generators included in CTPG's studies will be modeled as must-run units; i.e., the output of renewable resources will not be reduced to mitigate any reliability criteria violations found in CTPG's studies (such as running out of fossil-fired generation that can be decremented

[8]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 .

to accommodate renewable resource output in the spring case – an over-generation condition). It should be noted that an evaluation of renewable integration requirements is outside the scope of CTPG's 2011 study work.

Table 16: Renewable Resources for each Scenario

Renewable Resource	Pacific Northwest Import		Northwest Nevada Import		South to North Flow		CPUC Public Policy		Central California		West of River Import	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Discounted Core	25,138	56	25,138	56	25,138	56	25,138	56	25,138	56	25,138	56
Scenario Specific	8,804	19	6,345	14	-	-	19,993	44	11,824	26	18,318	40
RETI Best CA CREZs	11,189	25	13,648	30	19,993	44	-	-	8,169	18	1,674	4
Total	45,131		45,131		45,131		45,131		45,131		45,131	

Table 17: POU/CPUC Discounted Core

	Installed Capacity (MW)					Annual Energy Production (GWh)					
CREZ/ Resource Location	Wind	Solar Thermal	Solar PV	Biomass/ Biogas/ Small Hydro	Geothermal	Wind	Solar Thermal	Solar PV	Biomass/ Biogas/ Small Hydro	Geothermal	Total
Carrizo South			800					1742			1742
Fairmont			230					537			537
Imperial		300	49		40		701	126		302	1128
Kramer		250					584				584
Mountain Pass		410					958				958
Palm Springs	77					230					230
Pisgah		500					1169				1169
Riverside East		642	550				1623	1283			2906
Round Mountain	0					0					0
San Bernardino-Lucerne	42					121					121
San Diego South											0
Santa Barbara	83					236					236
Solano	166					545					545
Tehachapi	1912		9			5388		19			5407
Victorville			10					22			22
Westlands			50					117			117
NonCREZ & distribution-level PV			1077	138				2172	1022		3194
Alberta	516					1410					1410
Arizona			290					737			737
British Columbia											0
Colorado											0
Idaho	90					229					229
Montana	300					994					994
Nevada-S		400	50				935	127			1062
New Mexico				32					238		238
Oregon	614					1571					1571
Wyoming											0
Total	3799	2502	3115	170	40	10724	5971	6881	1261	302	25138

Table 18: Pacific Northwest Scenario Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	120	303		23		445	TBD	TBD		TBD			336	707		171		1,214
Imperial North A**					230	230					TBD						1,737	1,737
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	34	1,040			5	1,079	TBD	TBD			TBD		97	2,432			38	2,567
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					64	64				TBD							485	485
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	114					114	TBD						319					319
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	170					170	TBD						477					477
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	537	1,210		7		1,754	TBD	TBD		TBD			1,514	2,828		48		4,391
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Pacific Northwest***	2,000												8,804					8,804
Total	**6,774**	**5,055**	**3,115**	**200**	**340**	**15,483**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**22,272**	**11,939**	**6,881**	**1,479**	**2,561**	**45,131**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

Table 19: Northwest Nevada Scenario Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	147	371		28		546	TBD	TBD		TBD			411	867		210		1,488
Imperial North A**					282	282					TBD						2,129	2,129
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	42	1,276			6	1,323	TBD	TBD			TBD		119	2,981			47	3,146
Lassen/NW Nevada***	200		50		750	1,000	TBD		TBD		TBD		563		127		5,655	6,345
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					79	79				TBD							594	594
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	140					140	TBD						392					392
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	208					208	TBD						585					585
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	659	1,484		8		2,150	TBD	TBD		TBD			1,856	3,468		59		5,383
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Total	**5,194**	**5,632**	**3,165**	**206**	**1,157**	**15,354**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**14,650**	**13,287**	**7,008**	**1,529**	**8,726**	**45,200**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

Table 20: South to North Flow Scenario Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	214	541		41		796	TBD	TBD		TBD			600	1,264		305		2,169
Imperial North A**					412	412					TBD						3,103	3,103
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	61	1,859			9	1,928	TBD	TBD			TBD		173	4,344			68	4,585
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					115	115				TBD							866	866
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	204					204	TBD						571					571
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	303					303	TBD						853					853
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	960	2,162		12		3,134	TBD	TBD		TBD			2,705	5,054		86		7,845
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Total	**5,541**	**7,063**	**3,115**	**223**	**575**		**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**15,626**	**16,633**	**6,881**	**1,652**	**4,338**	**45,130**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

Table 21: CPUC Public Policy Scenario Renewable Dispatch

	Installed Capacity (MW)					Dispatched (MW)					Annual Energy Production (GWh)					
CREZ/ Resource Location	Wind	Solar Thermal	Solar PV	Biomass/ Biogas/ Small Hydro	Geothermal	Wind	Solar Thermal	Solar PV	Biomass/ Biogas/ Small Hydro	Geothermal	Wind	Solar Thermal	Solar PV	Biomass/ Biogas/ Small Hydro	Geothermal	Total
Carrizo South*			800										1742			1742
Carrizo South**			71					TBD					154			154
Fairmont*			230										537			537
Imperial*		300	49		40							701	125		302	1128
Imperial**	69	0	0		852	TBD	TBD	TBD		TBD	194	0	0		6426	6620
Kramer*		250										584				584
Mountain Pass*		410										958				958
Mountain Pass**	80	0				TBD	TBD				216	0				216
Palm Springs*	77										230					230
Palm Springs**	71					TBD					213					213
Pisgah*		500										1169				1169
Riverside East*		642	550									1623	1283			2906
Round Mountain*	0										0					0
Round Mountain**	0				15	TBD				TBD	0				108	108
San Bernardino-Lucerne*	42										121					121
San Bernardino-Lucerne**	155					TBD					446					446
San Diego South**	479					TBD					1369					1369
Santa Barbara*	83										236					236
Santa Barbara	83					TBD					236					236
Solano*	166										545					545
Solano**	261					TBD					856					856
Tehachapi*	1912		9								5388		19			5407
Tehachapi**	1087		0	26		TBD		TBD	TBD		3066		0	195		3260
Victorville*			10										22			22
Westlands*			50										117			117
NonCREZ & distribution-level PV*			1077	138									2172	1022		3194
NonCREZ & distribution-level PV**	297		977	46		TBD		TBD	TBD		879		2008	339		3227
less CPUC-approved distribution-level PV in CTPG net short*			(1052)										(1843)			(1843)
Alberta*	516										1410					1410
Arizona*			290										737			737
British Columbia**				35					TBD					263		263
Colorado**	297					TBD					825					825
Idaho*	90										229					229
Idaho**	0			24	95	TBD			TBD	TBD	0			154	685	839
Montana*	300										994					994
Nevada-S*		400	50									935	127			1062
New Mexico*				32										238		238
New Mexico**	632			0	14	TBD			TBD	TBD	1789			0	110	1899
Oregon*	614										1571					1571
Oregon**	0			69		TBD			TBD		0			510		510
Wyoming**	324			1		TBD			TBD		1020			11		1031
Total	7551	2502	3111	371	1017	TBD	TBD	TBD	TBD	TBD	21597	5971	7200	2733	7631	45131

*From CPUC/POU Discounted Core CREZs
**Scenario Specific Resources

Table 22: Central California Scenario Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	87	221		17		325	TBD	TBD		TBD			245	516		125		886
Imperial North A**					168	168					TBD						1,268	1,268
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	25	760			4	788	TBD	TBD			TBD		71	1,775			28	1,874
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					47	47				TBD							354	354
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	83					83	TBD						233					233
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	124					124	TBD						349					349
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	392	883		5		1,280	TBD	TBD		TBD			1,105	2,065		35		3,205
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Gates***	103		3,102			3,205							288		7,242			7,530
Midway***			1,348	8		1,356									3,147	59		3,206
Panoche***			466			466									1,088			1,088
Total	**4,614**	**4,366**	**8,031**	**200**	**259**	**17,468**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**13,015**	**10,328**	**18,358**	**1,480**	**1,951**	**45,131**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

Table 23: West of River Import Scenario with 50% Eldorado Injection Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	18	47		3		69	TBD	TBD		TBD			50	111		26		186
Imperial North A**					34	34					TBD						260	260
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	5	156			1	162	TBD	TBD			TBD		14	364			6	384
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					10	10				TBD							72	72
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	17					17	TBD						48					48
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	25					25	TBD						71					71
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	80	181		1		262	TBD	TBD		TBD			227	423		7		657
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Eldorado (50%)***	1,521	1,100	1,000			3,621							4,259	2,567	2,335			9,161
Palo Verde(37.5%)***	1,544	510	580			2,634							4,323	1,190	1,354			6,868
North Gila (12.5%)***		436	545			981								1,018	1,272			2,290
Total	**7,010**	**4,932**	**5,240**	**174**	**85**	**17,441**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**19,717**	**11,644**	**11,842**	**1,293**	**640**	**45,136**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

Table 24: West of River Import Scenario with 50% Palo Verde Injection Renewable Dispatch

CREZ	Installed Capacity (MW)						Dispatched (MW)						Annual Energy (GWh)					
	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total	Wind	Solar Thermal	Solar PV	Bio	Geo	Total
Carrizo North/South*			800			800			TBD						1,742			1,742
Fairmont*			230			230			TBD						537			537
Fairmont**	18	47		3		69	TBD	TBD		TBD			50	111		26		186
Imperial North A**					34	34					TBD						260	260
Imperial South*		300	49		40	389		TBD	TBD		TBD			701	125		302	1,128
Kramer*		250				250		TBD						584				584
Kramer**	5	156			1	162	TBD	TBD			TBD		14	364			6	384
Mountain Pass*		410				410		TBD						958				958
Palm Springs*	77					77	TBD						230					230
Pisgah*		500				500		TBD						1,169				1,169
Riverside East*		642	550			1,192		TBD	TBD					1,624	1,283			2,906
Round Mountain**					10	10				TBD							72	72
San Bernardino-Lucerne*	42					42	TBD						121					121
San Diego-South**	17					17	TBD						48					48
Santa Barbara*	83					83	TBD						236					236
Solano*	166					166	TBD						546					546
Solano**	25					25	TBD						71					71
Techachapi*	1,912		9			1,920	TBD		TBD				5,388		19			5,407
Techachapi**	80	181		1		262	TBD	TBD		TBD			227	423		7		657
Victorville*			10			10			TBD						22			22
Westlands*			50			50			TBD						117			117
Alberta*	516					516	TBD						1,410					1,410
Arizona*			290			290			TBD						737			737
Idaho*	90					90	TBD						229					229
Montana*	300					300	TBD						994					994
New Mexico*				32		32				TBD						238		238
Nevada S*		400	50			450		TBD	TBD					935	127			1,062
Non CREZ*			1,077	138		1,215		TBD	TBD	TBD					2,172	1,022		3,194
Oregon*	614					614	TBD						1,571					1,571
Palo Verde (50%)***	1,521	1,100	1,000			3,621							4,259	2,567	2,335			9,161
Eldorado(37.5%)***	1,544	510	580			2,634							4,323	1,190	1,354			6,868
North Gila (12.5%)***		436	545			981								1,018	1,272			2,290
Total	**7,010**	**4,932**	**5,240**	**174**	**85**	**17,441**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**19,717**	**11,644**	**11,842**	**1,293**	**640**	**45,136**

*From CPUC/POU Discounted Core CREZs

**From RETI Best CA CREZs

*** Scenario Specific Resources

7 Generation Re-Dispatch

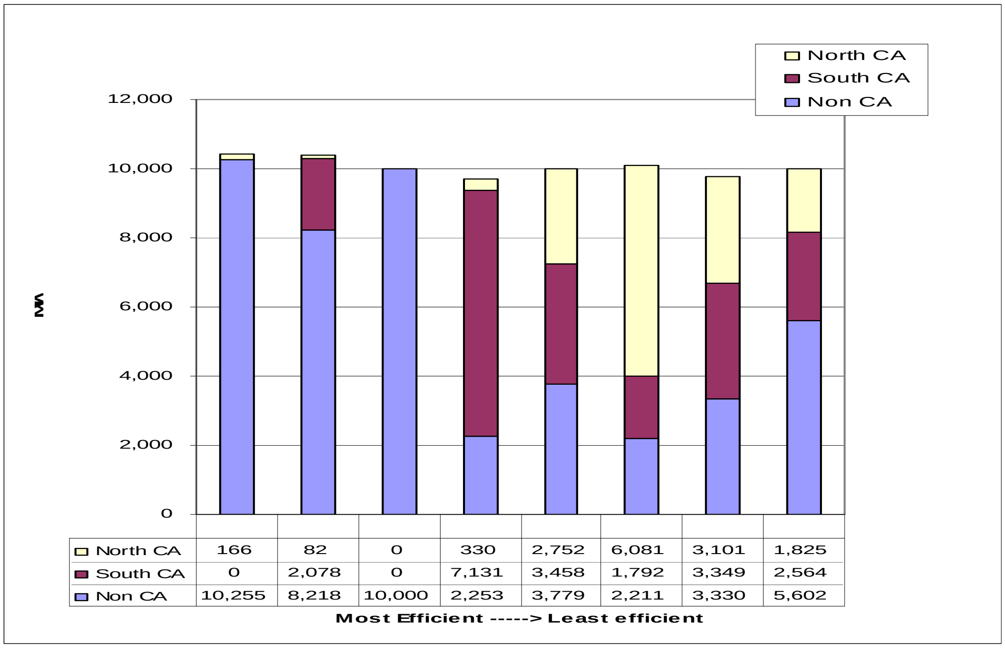
When renewable resources are added to the pre-renewable power flow cases and dispatched at the output level corresponding to the applicable technology and the month and hour being simulated, an equal amount of fossil-fueled generation must be turned down (or decremented) in order to maintain a generation-load balance in the power flow program. Fossil generation was selected for reduction because of economics. With renewable generation mandated to occupy 33% of the electricity market in California, fossil generation must compete to remain in the market. It is anticipated that the least efficient units, in the absence of overriding reliability and/or operational requirements, will be the most likely to shut down by 2020. Fossil generation will be decreased in a merit-order fashion (least economic reduced first) across the WECC. 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. Fossil units are decremented equally in blocks until all units in the block are turned off. Decrements below minimum output level are not allowed; i.e., the unit is turned off. Nuclear, qualifying facilities/cogeneration, and hydro units are not decremented in the summer peak cases.

Because of their location, some fossil generation may be required to operate for local reliability reasons even though their variable operating costs are relatively high and application of a strict economic merit-order economic dispatch would suggest they should not be run. CTPG will limit generation decrements to levels above known local capacity requirements as identified by the applicable balancing authority or as suggested by an examination of a WECC economic grid simulation case conducted by the CAISO in connection with the CAISO's 2010/2011 transmission planning process.

The CTPG has issued a survey to transmission planning entities throughout WECC to identify dispatchable generators, obtain minimum output of dispatchable units and descriptions of constraints requiring specific dispatchable units to be on line for specific system conditions. While not all WECC entities responded to the survey, the majority did and those responses have been incorporated into the economic merit-order list of WECC generators that may be decremented in the power flow program. The economic merit-order list of dispatchable gas-fired generators is provided on a spreadsheet that will be available on the CTPG web site.

Figure 1 provides a summary of the fossil units in WECC ranked by efficiency in the horizontal axis. Each column represents approximately 10,000 MW with the most efficient on the left and the least efficient on the right. The figure reflects both the CTPG assumptions regarding OTC units and the WECC survey results for dispatchable generation. The colors distinguish resources located in Northern California, Southern California and outside California.

Figure 1: WECC Install Capacity
Dispatchable Gas-Fired Generation



While the economic merit-order list of dispatchable gas-fired generators excludes any generators that WECC entities identified as must-run, it does not indicate the minimum amount of generation that must be on-line in specific load pockets for the system conditions that will be evaluated in CTPG's studies. Other documents will be used to determine what these minimum amounts are.[9]

The CAISO has published a December 30, 2010 document entitled *2013-2015 Local Capacity Technical Analysis, Report and Study Results* which sets forth the minimum amount of dependable generating capacity that must be available in the following load pockets within the CAISO BAA: Humboldt, North Coast/North Bay (northeast of San Francisco), Sierra, Stockton, Greater Bay (east of San Francisco), Greater Fresno, Kern, Los Angeles Basin, Big Creek/Ventura and San Diego. This document is available at http://www.caiso.com/287c/287ca3cc28a80.pdf.

Minimum generation requirements in the San Diego area are governed by San Diego Area Unit Commitment Requirements for Voltage Stability and by the Local San Diego Area 25% Minimum Generation Requirement. These minimum generation requirements are described in the document named "*San Diego Area Generation Constraints*" which is available on the CTPG web site. Minimum generation requirements in the San Diego area are governed by San Diego Area Unit Commitment Requirements for Voltage Stability and by the Local San Diego Area 25% Minimum Generation Requirement. These minimum generation requirements are

[9] The WECC survey provided some information on minimum generation requirements, particularly for certain areas of California. The WECC survey yielded limited information on minimum generation requirements in areas outside of California; it is not known whether this is because there are few limits or because the WECC entities have simply not provided it. CTPG anticipates an ongoing effort to collect and refine information regarding minimum generation requirements throughout the WECC.

described in the document named “*San Diego Area Generation Constraints*” which will be available on the CTPG web site. The Los Angeles basin area served by SCE is subject to a similar minimum generation requirement.

Within the SMUD BAA, there are two minimum generation requirements. One ties the minimum amount of generation that must be committed within a defined SMUD load area to load levels within the SMUD load area. The other ties the minimum amount of generation which must be committed from among a specific set of generators to load levels within a defined Sacramento load area. A document setting forth these requirements will be posted on the CTPG website.

MID has minimum on-line generation requirements tied to the MID distribution service area’s daily peak loads. A document setting forth these requirements will be posted on the CTPG website.

TID has minimum on-line generation requirements tied to the TID distribution service area’s daily peak loads. A document setting forth these requirements will be posted on the CTPG website.

Associated with Path 15 is a remedial action scheme (RAS) which drops specific generators south of Midway substation as well as load north of Los Banos Substation. If this generation is decremented, the RAS become less effective and Path 15 must be de-rated in the south to north direction. To prevent this de-rate in the study, the decision was made to not decrement the associated generators.