Corrected June 11, 2012

TRANSMISSION IMPACTS IN THE DRECP

Typographical corrections have been made in this report as of 6/01/2012.
These corrections can be found in the report as follows:

- p. 1: Clarification that the greenhouse gas emissions are from the electricity sector in California
- p. 5: Assumption 7 modified to reflect that the study actually assumed the use of available transmission capacity for a portion of the RESA deliveries as indicated by the CTPG pre-renewable study case.
- p. 34: Section title changed from "Delivery of Transmission in the Low Capacity Scenario" to "Conceptual Delivery Lines in the Low Capacity Scenario"
- p. 35: Section title changed from "Delivery of Transmission in the High Capacity Scenario" to "Conceptual Delivery Lines in the High Capacity Scenario"
- p. A-6: Added footnote to the heading in the last Column of Table A-4: "1-500 kV circuit = 1200 - 1500 MW capacity."
- p. A-8: Modified footnote 12 to read: "1-500 kV circuit = 1200 - 1500 MW capacity."
- p. A-8: Moved modified footnote 12 in Table A-5 to the heading in the last column of Table A-5.
- p. A-9: Modified footnote 13 to read: "Fall conditions were found to be most limiting for northbound deliveries to Northern California and the Northwest."

Transmission Impacts in the DRECP

1 OVERALL PURPOSE

The Desert Renewable Energy Conservation Plan (DRECP) is a proposed multi-species Habitat Conservation Plan (HCP), Natural Communities Conservation Plan (NCCP), and Land Use Plan Amendment (LUPA) intended to conserve threatened and endangered species and natural communities in the Mojave Desert and Colorado Desert regions of Southern California, while also facilitating the timely permitting of renewable energy projects within the deserts.

Pursuant to the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), the California Energy Commission (Commission), the U.S. Fish and Wildlife Service (Service), and U.S. Bureau of Land Management (BLM) are preparing a joint Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) for the DRECP. The project description of the EIR/EIS must include not only the renewable energy development and conservation areas, but also a description of transmission development required to carry the renewable electricity generated to the customers served by the renewable power.

2 INTRODUCTION AND OBJECTIVE

The DRECP released its Preliminary Conservation Strategy (PCS) in October 2011 (Commission 2011a) to facilitate the planning of both renewable energy generation development and conservation. Renewable Energy Study Areas (RESAs) were identified by the Renewable Energy Action Team (REAT) agencies based on consideration of available renewable energy resources and lower biological conflict areas. RESA boundaries depicted on the PCS map[1] have been used to identify the potential locations of generation when assessing the likely necessary transmission additions that may be required to deliver these resources to load.

The Renewable Portfolio Standard and Acreage Calculator (Commission 2011b) was developed by the Commission as a tool to estimate the acreage of land required for renewable energy that would be needed to attain specific reductions in greenhouse gas emissions from the electricity sector in California. The reduction chosen for the low acreage scenario was 58% below 1990 levels; the high acreage scenario was 80% below 1990 levels.[2] The calculator was used to estimate the acreages of land that would be required to attain specific levels of greenhouse gas reductions. These acreage estimates

[1] Figure 2-1 from the Preliminary Conservation strategy

[2] Eight percent of sectoral reductions were allowed to be obtained in the form of offsets from other sectors of the economy, allowing for an equivalent amount of greenhouse gas emissions from the electricity sector.

were then converted into megawatts (MWs), using specific land use requirements for each technology (e.g., geothermal requires 6 acres/MW, while wind requires 40 acres/MW). These values, expressed in MWs for 2040 and 2050, were provided to the Transmission Technical Group (TTG) and formed the major underlying generation assumption of the TTG's work.

The TTG[3] was created by the REAT agencies in January 2012. The TTG was assigned the responsibility to develop an estimate of land acreage that could be affected by transmission upgrades that would be needed to connect and deliver specified amounts of renewable power from within draft RESAs to the ultimate buyers of the renewable energy. This is hereafter referred to as "load" since customer load centers are used as a proxy for the "buyer." The RESAs used by the TTG in this effort are areas within the Plan Area identified in the PCS as being most compatible with generation development and generally having lower overall conservation value.

The process undertaken by the TTG identified the necessary transmission system facility additions to accommodate a pre-specified number of MWs of renewable generation that could be developed in the RESAs by the 2040 and 2050 timeframes. The starting assumptions for the low and high generation scenarios are taken directly from the Commission's Renewable Portfolio Standard and Acreage Calculator (Commission 2011b). The generation scenario estimates were then adjusted downward to account for generation projects that have reached a stage of development where the generation operating date is after December 31, 2011, and there is an associated transmission plan for interconnection and delivery, which is currently under construction having already secured a Certificate of Public Convenience and Necessity (CPCN). Each new element of the required transmission system (e.g., substation, transmission line) has an assumed MW capacity to accommodate generation and an associated amount of land that would be impacted by its construction and operation (e.g., a Southern California Edison [SCE] 230/66-kilovolt [kV] substation requires about 77 acres of land). The TTG compiled the likely transmission system additions by matching the transmission component capacity to the renewable generation capacity in each RESA for 2040 and 2050. Using the associated acreages affected for each new component, a tally of the acreages likely to be affected was then developed. Arriving at the affected land acreage value for each renewable generation scenario and for each RESA was the goal of this work. The transmission requirements described herein include the likely bulk network

[3] The TTG was composed of representatives from the California Energy Commission, California Independent System Operator, California Public Utilities Commission, Imperial Irrigation District, Los Angeles Department of Water and Power, Pacific Gas and Electric, San Diego Gas and Electric, Southern California Edison, and the U.S. Military.

transmission lines and substations, as well as the collector lines (also known as the radial generation tie lines) necessary to connect and deliver renewable energy projects to load.

3 OVERVIEW OF PLANNING APPROACH

In developing the description of potential land impacts due to the transmission that would be needed to interconnect and deliver renewable generation, the aim was to develop a conceptual transmission plan that considered each RESA, each generation scenario (2040 and 2050), and considered the additional transmission that could be needed to interconnect the renewable generators in each RESA, collect renewable generation, and deliver the renewable power to assumed delivery locations (load). This process relied on several transmission assumptions, including the following:

1. The DRECP TTG is conducting an evaluation to determine the requirements of a conceptual transmission plan and its associated land impacts. The TTG is not conducting a siting evaluation. None of the typical power systems analysis activities, such as power flow studies or stability studies, would be conducted. The conceptual transmission plans and associated impacts would be the result of the judgments of the experienced transmission planners representing the major utilities from across the state participating on the TTG.

2. Guiding principles for the work include planning of rational, orderly, cost-effective transmission additions that would allow for phased development. Examples of how these guiding principles were invoked include the following:

    a. It is rational to assume that conservation goals would strive to both minimize the total footprint of grid facilities and to utilize land of lower biological value. Therefore, the conceptual transmission plan should strive to minimize its overall footprint by assuming that transmission would be shared among developers to the extent possible within each RESA.

    b. It is consistent with conservation goals to minimize disturbance within the desert areas by avoiding repeated teardown and rebuild of facilities. Therefore, the conceptual transmission plan should strive to identify an ultimate plan to meet the requirements of 2050, and then utilize a subset of the components to meet the requirements of 2040 to avoid teardown and rebuild and to reflect the phasing in of facilities over time.

c. It is orderly to plan for slightly larger substation footprints to manage the land congestion that can arise when many lines converge on a collector substation and physical space is quickly used up. This would also facilitate the eventual siting of the substation and the desire to keep facilities confined to lands of lower biological value.

d. It is cost effective to utilize fewer components that are of sufficient size to collect and deliver most of the renewable generation from the RESA, but also recognize and provide for smaller facilities. These facilities may be inevitable and necessary due to unique physical locations and other opportunities that may develop for the renewable generation.

3. The conceptual transmission plan components are assumed to have no preferred developer or owner.

4. The generation in each RESA is assumed to have no preferred developer or owner.

5. The generation analysis assessed existing generation with operational dates before January 1 2012. Any generation in a RESA and also in the California Independent System Operator (CAISO) interconnection queue, for which utility side transmission is under construction (having already secured a CPCN) has been removed from the RESA generation estimates. All other generation in the CAISO queue within the RESA boundaries was assumed to be included in the RESA generation amount estimates for which conceptual transmission plans would be developed.

6. The RESA output was assumed to be transferred to the following delivery point destinations:
   a. 25% would be delivered to load centers in Southern California;
   b. 25% would be delivered to load centers in Northern California;
   c. 25% would be delivered to load centers in the Pacific Northwest (PNW); and
   d. 25% would be delivered to load centers in states of the Southwest (SW), including Arizona, Nevada, and New Mexico.

7. The study assumes that a combination of available transmission capacity and new capacity would be utilized to accommodate RESA deliveries to the four delivery destinations, listed above. The available transmission capacity in 2040 and 2050 would be as indicated by the 2020 pre-renewable cases prepared by the California Transmission Planning Group (CTPG). The underlying assumption is that in the years leading up to 2040 and 2050 transmission upgrades for load growth and other grid-related expansion requirements would be implemented so that the available capacity indicated by the 2020 CTPG case would be a reasonable proxy for the available capacity in 2040 and 2050.

8. To establish the delivery transmission impacts associated with RESA deliveries to all four delivery point destinations described in Item 6, CTPG pre-renewable cases ("0" cases), which were developed in 2011, were reviewed. These cases model 2020 spring, 2020 summer, and 2020 fall conditions and establish the flows that would be assumed for 2040 and 2050 prior to dispatching the RESA generation. This review showed that the CTPG 2020 Spring Case "0" is the limiting case as it has the highest west-bound flows from five RESAs in Southern California and would result in the most transmission impacts on the Southern California transmission system associated with deliveries of RESA output to Southern California, Northern California, and PNW. As such, the CTPG 2020 Spring Case "0" Flows would be used to help establish the conceptual new delivery lines in Southern California to deliver RESA power to Southern California delivery point destinations. Similarly, the review also showed that the CTPG 2020 Fall Case "0" is the limiting case as it has the highest north-bound flows and would result in the most transmission impacts associated with deliveries of RESA output to Northern California and PNW. As such, the 2020 Fall Case "0" would be used to help establish the conceptual new delivery lines from Southern California to Northern California and PNW.

In order to facilitate the development of the conceptual transmission plan for California RESAs and its description by utilizing the planning resources of the five major California utilities and three balancing authorities, it is vital to develop a standardized methodology and process and come to a common understanding on its utilization by all parties. The following list summarizes the overall sequence of analysis used by the TTG. It provides a systematic approach to developing the impacts analysis and responds to the generation scenarios laid out by the REAT agencies. Available information relating to currently proposed locations for generation facilities was used to determine the likely aggregation and distribution of generators in 2040 and 2050. Key assumptions were made at each stage, as described in Section 4. The plan development sequence was as follows:

a. Assess the amounts out of the total high (2050) and low (2040) RESA renewable MW scenarios that can be interconnected and delivered utilizing the approved transmission projects (with secured CPCN) currently under construction and planned to be in service in the 2010–2020 timeframe. Subtract out this planned available capacity amount from that required for the low and high RESA renewable scenarios to give the net, unplanned future transmission capacity requirements (see Section 4.1).

b. Identify a series of standardized transmission grid components that can be mixed and matched across the entire DRECP RESA renewable resources (see Section 4.2).
    i. A set of standardized transmission and substation components were defined that would be compatible in size and voltage with the local area transmission in order to facilitate the connection of renewable generation to the bulk electric network;

    ii. An assumed MW capacity to accommodate RESA renewable generation was defined for each standardized component; and

    iii. An assumed land footprint was defined for each standardized component that would facilitate the calculation of total acreage that would be affected by the construction, operation, and maintenance of each standardized component.

c. Lay out collector (gen-tie) lines derived from the likeliest locations for generation development within the identified RESAs; potential locations to be derived from currently known proposed projects (see Section 4.3).

d. Identify potential locations for hub collector substations based upon the likeliest locations for generation development within each RESA (summarized in Section 5.1).

e. Develop the most reasonable interconnection locations to the current bulk transmission grid (summarized in Section 5.1) based on currently known grid configuration, load growth patterns, and reliability compliance needs.

f. Identify the delivery point destinations for the renewable generation from all the RESAs, as described in Item 36 above under foundational assumptions.

g. Identify necessary "delivery lines" bulk transmission system upgrades required to deliver RESA renewable generation from each RESA's collector hub substations to buyers' load centers at major grid substations in all four destination regions identified earlier in Item 3 under foundational assumptions and also summarized in Section 5.2.

h. Assess and identify the likely land acreage impacts on the desert from interconnecting RESA generation resources, collector lines, and delivery lines with the bulk transmission system.
i. Estimate the likely transmission lines right-of-way (ROW) requirements and determine the likely acreage that could be impacted in higher and lower sensitivity biological areas within the DRECP map boundary.

This planning approach clearly points the way toward managing eventual siting activities and other RESA development activities that would be consistent with the overall goals of the DRECP as well as ensuring that these objectives are achieved over the RESA development time horizon. An example of this would be that the conceptual transmission plan, based on the types of lands contained within the RESA, could inform eventual siting activities that would presumably strive to utilize land of lower biological value (e.g., already disturbed land) and hence improve upon the DRECP goals. The conceptual plan could also serve as a benchmark against which development and its corresponding acreage could be measured as well as managed. Although some biologically sensitive areas within the RESAs may inevitably be utilized for generation and transmission, the opportunity exists for conservationists to assist with the difficult choices that may be needed in order to assure the larger goals of the DRECP are achieved. These opportunities will be left for later discussion once the overall DRECP and TTG plans are finalized.

4 KEY ASSUMPTIONS IN DEVELOPING THE CONCEPTUAL TRANSMISSION SCENARIO

4.1 Estimating Transmission Capacity Requirements for Each RESA

The DRECP team developed high and low generation scenarios for renewable development in RESAs. These generation scenarios define the maximum MWs that could be developed in a low (2040) and high (2050) case with an assumed mixture of technologies. These scenarios were adjusted for renewable generation projects that already have approved transmission projects currently under construction for interconnection and delivery. The conceptual transmission plans that have been developed are driven by these adjusted generation scenarios and describe the maximum potential transmission build-out in the low and high generation cases. Each scenario has been analyzed independently; however, every attempt was made to assure that the 2040 conceptual transmission plan could be phased in to a 2050 conceptual transmission plan. In a completely independent assessment of the low generation scenario, where there might be little concern for a high generation scenario, the conceptual transmission plan developed could differ from the one presented here. For example, using a phased approach, a transmission tower capable of eventually carrying a 230 kV double circuit line might be put in place by 2040, but not be completely filled until 2050. In another example, a 500 kV tower could be installed in 2040, and operated initially at 230 kV, and its operation converted to 500 kV in 2050. In both cases, the larger land impact of this conceptual transmission plan would be felt in 2040, with a much smaller—or very little incremental impact—in 2050.

However, the choice to install upgradable facilities could be different if the high generation scenario needs were not also considered. If only the needs of the low generation scenario were under consideration, the better decision could have been just a single circuit 230 kV line. Given the DRECP instructions to the TTG to plan for two scenarios 10 years apart, the prudent approach was taken to avoid the possibility of having to tear down single circuit 230 kV lines and rebuild those facilities again for the higher generation scenario after 10 years. When possible, accommodating a phased construction approach was chosen.

To ensure that current transmission plans are accounted for, the TTG planners subtracted the capacity of known collectors and approved delivery line projects currently under construction from the transmission requirements for both scenarios. Table 4-1 gives the net breakdown of the expected capacity requirements when current transmission projects are taken into account. Transmission requirements for the low scenario are reduced from 21,472 to 15,172 MW and for the high scenario from 40,407 to 34,107 MW.

The distribution of renewable generation technology is RESA-specific. Each RESA was assigned a technology mix that, when combined with other factors in the Renewable Portfolio Standard and Acreage Calculator (Commission 2011b), provides high and low estimates of potential generation development capacity (see Table 4-1). For transmission, the technology mix is important when assessing the maximum simultaneous delivery capacity for collector lines from all generators, as this would indicate the maximum MW (size) of a line. The maximum simultaneous delivery capacity is defined as the point during the annual load cycle that delivery to load is likely to peak. This is primarily driven by the mix of wind and solar generation.

Table 4-1
High and Low Acreage RESA Renewables MW Scenarios

RESA	Technology	MW Capacity Low Scenario (1)	Known Transmission Under Construction (2)	Low Scenario Net Transmission Short (3)	MW Capacity High Scenario (4)	Known Transmission Under Construction (5)	High Scenario Net Transmission Short (6)
Barstow	Solar	836	0	836	1,252	0	1,252
	Wind	540	0	540	1,838	0	1,838
	Distributed Generation	177	0	177	353	0	353
Blythe	Solar	1,303	497	806	1,952	564	1,388
	Distributed Generation	271	103	168	123	36	87
Imperial	Geothermal	3,012	483	2,529	4,016	434	3,582
	Solar	3,693	592	3,101	5,531	597	4,934
	Distributed Generation	781	125	656	1,562	169	1,393
Owens Valley	Solar	414	0	414	621	0	621
West Mojave	Solar	5,621	2,422	3,199	8,419	1,636	6,783
	Wind	3,635	1,566	2,069	12,362	2,402	9,960
	Distributed Generation	1,189	512	677	2,378	462	1,916
Total	—	**21,472**	**6,300**	**15,172**	**40,407**	**6,300**	**34,107**

Note: The transmission accounted for (columns 2 and 5) includes the Tehachapi Renewable Transmission Project (TRTP) @ 4,500 MW, Devers–Colorado River Transmission Line (DCR) @600 MW, and Sunrise Powerlink @1,200 MW for a total of 6,300 MW.

4.2 Standardized Grid Components and Expected Acreage Impacts

As stated in Section 3, standard transmission grid components were used to develop the transmission scenario. This approach allowed for the assembly of the various components of the transmission system to derive a strategic conceptual transmission plan.

For substations, simple assumptions can be made about the expected acreages of permanent land conversion that are dependent upon the transmission voltages the substation is designed to serve.

Transmission impacts are challenging to quantify, as permanent land conversion is a small proportion of their relative impact. Transmission lines are therefore quantified by both length (feet) to give an estimate of their linear impact across the landscape, and by the ROW requirements (width) to give an affected acreage and integrate the size of the structures needed.

Acreage impacts vary depending on the method by which transmission is constructed and accessed. If a permanent access road is necessary, the impacts would be greater than if construction and maintenance are carried out using helicopters. Table 4-2 provides typical expected impacts for standard bulk transmission components. For the purpose of ROW requirements, each 230 kV and 500 kV line is assumed to require a permanent access road and normal construction methods are used during the building process.

Table 4-2
Typical ROW Widths and per Mile Impacts of Bulk Transmission

Voltage Level	Towers *Per Mile*	ROW *Tower Width (ft.)*	ROW *Access Road Width (ft.)*	*Acreage Impact (Acres)*
500 kV[4]				
• Single Circuit Tower Line	11	200	24	27
• Two Single Circuit Tower Line	11	450	24	57
• Three Single Circuit Tower Line	11	700	24	88
• Four Single Circuit Tower Line	11	950	24	118.0606
230 kV				
• Double Circuit Tower Line	11	100	24	15.0303
34.5 and 66 kV				
• Double Circuit Tower Line	11	30	N/A	3.6364

The basic transmission components and assumptions are:

- **34.5 and 66 kV collector lines –** Also known as generation interconnection lines or gen-ties. Collector lines are used for projects less than or equal to 100 MW. All 66 kV lines are assumed to be 10 miles (52,800 feet) long and to have a ROW (width) requirement of 30 feet with no access road requirement, for standard affected acreage of 36 acres. All 66 kV transmission lines are assumed be double circuit for their entire length. Whether double circuit or single circuit collector lines are utilized in the conceptual transmission plan, they are assumed to occupy a 30-foot ROW. These assumptions assure maximum utilization of facilities within the ROW.

[4] ROW spacing is based on Western Electricity Coordinating Council (WECC) Adjacent Circuits definition in order to avoid credible N-2 contingency considerations.

- **230 kV collector lines** – Gen-ties of 230 kV are required for projects of greater than 100 MW and have varying lengths. All double circuit 230 kV lines have a ROW requirement of 100 feet with an additional 24 feet for road access. All lines were assumed to occupy a 124-foot ROW. A 230 kV collector line can be of variable length and calculation of the acreage is necessary for each line based on its length. Whether double circuit or single circuit, each 230 kV line is assumed to occupy the same ROW width.
- **66 kV collector substation** – A 66 kV collector substation serves as the receiving point for 66 kV collector transmission lines and is an addition to an existing 500/230 kV substation. These substations require 39 acres of additional permanent impacts.
- **230/66 kV collector substation –** A 230 kV collector substation serves as the receiving point for both 230 and 66 kV collector transmission lines. These substations require 77 acres of permanent impacts.
- **500/230 kV collector substation –** A 500/230 kV substation serves as the receiving point for 500 kV and 230 kV collector lines and 220/66 kV collector substations. These substations require 176 acres of permanent impacts.
- **500/230/66 kV super collector substation** – The most flexible substation as it can serve as the receiving point for 500 kV, 230 kV, and 66 kV collector lines and 230 and 500 kV lines that connect this facility to the local bulk electric grid. These substations require 215 acres of permanent impacts.
- **230 kV connector lines** – A line that connects 230/66 kV collector substations to 500/230 kV collector substations and to logical points on the existing high voltage transmission grid. All double circuit 230 kV lines have a ROW requirement of 100 feet with an additional 24 feet for road access. Therefore, all lines are calculated with a 124 feet ROW. Collector line lengths can vary so the acreage is calculated individually for each line. Whether double circuit or single circuit, 230 kV lines are assumed to occupy the same ROW.
- **500 kV connector lines** – A line that connects 500/230 kV collector substations to logical points on the existing high voltage transmission grid. Individual single circuit 500 kV lines have a ROW requirement of 200 feet with an additional 24 feet for road access. Multiple single circuit 500 kV lines situated immediately adjacent to each other would occupy 250 feet centerline to centerline using Western Electricity Coordinating Council (WECC) spacing in order to avoid classification as adjacent circuits and also would include 24 feet for road access. By avoiding adjacent circuit classification, this analysis can obviate the need to address double line contingency

outage problems. A 500 kV collector line can be of variable length so the acreage is calculated individually for each line.

- **Delivery lines** – Single circuit 500 kV transmission lines are used as delivery lines. Individual single circuit 500 kV lines have a ROW requirement of 200 feet with an additional 24 feet for road access. Multiple single circuit 500 kV lines next to each other would employ 250 feet centerline to centerline using WECC spacing in order to avoid classification as adjacent circuits and also would include 24 feet for road access. By avoiding adjacent circuit classification, this analysis can obviate the need to address double contingency outage considerations. A 500 kV delivery line can be of variable length so the acreage is calculated individually for each line. A single DC delivery line is described in the plan to accommodate power transfer to the Los Angeles Basin. It is, for the purposes of analysis, treated as a single 500 kV line.

4.3 Identifying Generation Distribution within the RESAs

Generation would not be developed evenly across all RESAs, but would be aggregated within RESAS or development focus areas (DFAs) due to a range of factors, including energy and biological resource distribution, as well as the existence of current transmission.

Understanding the likely aggregation and distribution of generation facilities as well as the size and technology mix is important when developing a high-level conceptual transmission plan. Such information informs all aspects of the planning process, including the expected length of gen-ties (collector lines), number and size and location of new collector substations, and likely length of delivery lines to the main transmission grid.

To gain the best estimate of generation distribution, the TTG used proposed project data currently collected and tracked by the Commission and the utilities (Commission 2011c). The Commission is currently tracking about 18,347 MW of proposed projects within the plan area, 80% of which are within the RESAs. Utilizing the Commission information in conjunction with each utility's interconnection queue provides a good proxy for the project distribution assumption.

Projects currently proposed within the Plan Area amount to 85% of the total capacity estimated necessary to meet the 2040 generation scenario. It is not unreasonable to assume that the project size (MW) and distribution that would meet the 2040 development scenario would approximate the distribution of projects currently in development.

Projects were categorized into groupings of projects less than 100 MW requiring a 66 kV collector line, and projects greater than 100 MW requiring a 230 kV collector line.

4.4 Assumptions about Bulk Transmission – Upgrades Major Transmission

To the extent that transmission will be required to deliver to Northern California destination load, Southern California destination load, or that such a large generation input has effects also on lines leaving California to go to PNW and SW, some estimate of likely size and direction of flow is necessary in order to assess likely upgrades necessary as a consequence of developing generation within the RESAs.

As a general understanding, physics determines where electricity flows on an electric grid. However, the methods employed in this planning exercise did not examine where the electrons would flow with any degree of technical precision. Instead, judgment was used to make assumptions regarding the delivery path by relying on the assumed delivery destinations for the DRECP resources. Thus, these conceptual transmission plans are intended to facilitate the delivery of a resource from its point of connection (RESA locations) to the electric grid to its ultimate delivery destinations by reinforcing the corresponding delivery path with new delivery lines.

The delivery lines in the conceptual transmission plan have been sized to carry the sum of the following two power components. The sum was further adjusted for any available transmission capacity on the existing bulk power transmission lines and paths to each of the four destination regions:

1. Pre-RESA MW Flow amounts on various bulk power transmission lines and paths as established by 2011 CTPG renewable studies for the year 2020 under their Spring '0' and Fall '0' cases.

2. Maximum simultaneous renewable output MW from each RESA based on its composition of renewable technology types for the April Hour '14' (on a 24-hour daily generation cycle) for the CTPG Spring Case '0' and the September Hour '09' (on a 24-hour generation cycle) for the CTPG Fall Case '0.'

For the target years 2040 and 2050, the maximum adjusted sum of the above two delivered "Pre-RESA Flow MW" and "RESA Simultaneous renewable generation MW" amounts was determined to be in the CTPG Spring Case '0' for delivery to Southern California destination and the CTPG Fall Case '0' for delivery to the Northern California and PNW destinations. Accordingly, delivery lines in Southern California are sized on data provided by the CTPG Spring Case '0,' whereas delivery lines in Northern California and to PNW destinations are sized on data provided by the CTPG Fall Case '0.'

The TTG anticipated that the renewable resource output of the RESAs would not only be used to serve California energy demands because of growing energy demands throughout the Western Interconnection and the economic replacement of lower efficiency existing fossil-fired generators throughout the western United States by RESA renewable energy resources. Therefore, the TTG assumed a 25% delivery of the total RESAs renewable output would serve Southern California demand; 25% serving the Desert Southwest demand; 25% serving the PNW demand; and 25% serving the Northern California demand. Such deliveries would be scheduled over existing and new AC and DC transmission facilities. A power flow simulation program would normally be used to determine the resultant distribution of power from generating resources to demand centers throughout the system. However, no power flow simulations were conducted for this exercise by TTG. The TTG used spreadsheet analysis to estimate the resultant power flows based on the RESAs renewable resource scheduling to delivery destinations.

5 CONCEPTUAL TRANSMISSION PLAN DESCRIPTION

The transmission plan is split into two sections:

(1) **Section 5.1** describes the acreage and linear feet of collector lines (gen-ties), and the transmission connection/delivery line upgrades are tabulated for both high and low scenarios. For substations, an estimate of acreage impact is given, based on the assumptions in Section 4.2. For each RESA, a brief description gives the assumptions made, including technology mix and project size. Collector and delivery lines are named using their two end points.

The West Mojave RESA was further divided into three sub-areas that currently have major bulk transmission lines to simplify the analysis. Accordingly, the West Mojave RESA is described in three parts.

(2) **Section 5.2** draws together the high voltage transmission upgrades described in Section 5.1 and includes additional transmission grid reinforcement necessary as a consequence of the potential additional generation. This section includes transmission located both in the Plan Area and any additional transmission upgrades outside the DRECP. Bulk transmission description includes a summary assessment of the upgrades in relation to existing transmission ROW; existing federal and BLM transmission corridors; mileages for transmission both in and outside the DRECP; and expected mileages within biologically sensitive areas.

All collector, substation, and connector line impacts are assumed to be within the RESAs. Delivery lines would be both inside and outside RESAs. Delivery lines are named by the substations where they begin and end; estimates of acreage and mileage within low-sensitivity and high-sensitivity areas are provided. All transmission infrastructures are assumed to avoid currently developed areas. Low-sensitivity areas are areas of low biological value and agricultural areas as defined in the PCS (Commission 2011a). High-sensitivity areas are classified as having moderate to high biological value (as described in the PCS). All lines were assumed to avoid military, legally and legislatively protected, Off-Highway Vehicle (OHV) Areas, and State Vehicular Recreation Areas (SVRA), unless they occupy an already defined federal or BLM energy corridor (Commission 2011a).

Each delivery and connector line is numbered. Lines given the same number in low and high scenarios occupy the same alignment but may differ in size and purpose.

5.1 Within RESA Upgrades

Upgrades and improvements are described for each RESA and identify the quantity and affected acreage of each component, the likely upgrades needed to deliver the low generation scenarios, and the net additional upgrades required to deliver the high generation scenario to load.

Owens Valley

At present, there are no proposed projects in Owens Valley. Consequently, for this conceptual scenario, Owens Valley development is assumed to be 100% solar with projects interconnecting to a single 230/34.5 kV substation (Table 5-1a), from which would radiate gen-tie lines to individual generation facilities (Table 5-1b). Connection to the main grid is assumed to be a minor loop in. No additional connector lines or grid re-enforcement would be required for Owens Valley.

Major Delivery Line Upgrades from Owens Valley

Delivery to the existing grid would be from a new Owens Valley substation via an 83-mile upgraded 230 kV transmission line to Barren Ridge substation at the northern most extreme of the Tehachapi RESA (Table 5-1c). The transmission alignment is assumed to be within the current federal corridor and parallel the current transmission, but would require new ROW as described in Table 5-1d.

Table 5-1a
Owens Valley – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*
230/34.5 kV	77	1	1	77	77
Total	—	—	—	**77**	**77**

Table 5-1b
Owens Valley – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Length (feet)	Length (feet)	Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*	*Low*	*High*
Double Circuit 34.5 kV	30	2	3	105,600	158,400	73	109
Single Circuit 230 kV	124	1	1	52,800	52,800	150	150
Total	—	—	—	**158,400**	**211,200**	**223**	**259**

Table 5-1c
Owens Valley – Connection and Delivery Lines (Connection to Main Grid)

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1	230 kV Delivery T/L	230 kV Delivery T/L	100	100	448,800	448,800	1,030	1,030
Total	—	—	—	—	**448,800**	**448,800**	**1,030**	**1,030**

Table 5-1d
Owens Valley – Characteristics of Major Grid Upgrades

Description	Voltage	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Low-Capacity Scenario	High-Capacity Scenario
New Owens Valley Substation to Barren Ridge	230 kV	Yes	Yes	85	78	7	Yes	Yes

Barstow

Based on the current proposed project size distribution profile (Commission 2011c), about 17% of proposed generation would be large (greater than 100 MW) projects and 83% small (less than 100 MW) projects. The Barstow RESA is estimated to require 3 (low scenario) to 4 (high scenario) new collector/connection substations (Table 5-2a). Generation interconnection (gen-tie lines) is sized and split proportionately (Table 5-2b) and would radiate from the collector substations to the generation.

In the high-capacity scenario, the gen-tie described in Table 5-2b would become a 500 kV connection line with the addition of the third substation (shown on Line 1 of Table 5-2c; Lines 2 and 3 of Table 5-2c are both substation connector lines).

The low-capacity scenario requires 230 kV connector lines from substations to the high-voltage transmission grid with an additional 230 kV gen-tie (Table 5-2b). In the high-capacity scenario, the transmission footprint would be similar but would include an additional substation and the replacement of a 230 kV collector with a 500 kV collector.

Major Delivery Line Upgrades from Barstow

Both low- and high-capacity scenarios would interconnect the Barstow area to the existing high voltage transmission grid via a new 500 kV transmission line (Table 5-2b). The line would run from a new substation near the Pisgah substation to the Mira Loma substation, outside the DRECP (Figure 1). The new 500 kV single circuit delivery line would be located within BLM energy corridors and run parallel to existing transmission but would likely need new ROW (Table 5-2d). A second 500 kV delivery line upgrade between Barstow and the Lugo–Victorville area also delivers the Barstow RESA output to the LA Basin.

Table 5-2a
Barstow – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*
220/66 kV	77	2	2	154	154
500/230 kV	176	1	1	176	176
500/220/66 kV	215	—	1	—	215
Total	—	—	—	**330**	**545**

Table 5-2b
Barstow – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Total Length (feet)		Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***	***Low***	***High***
Double Circuit Single Strung 66 kV	30	1	3	52,800	158,400	36	108
Double Circuit Double Strung 66 kV	30	6	13	316,800	686,400	218	473
Single circuit 230 kV	124	1	—	126,720*	—	361	—
Single circuit 230 kV	124	—	1	—	26,400	—	75
Total	—	—	—	**496,320**	**871,200**	**615**	**656**

Note: *Replaced by connector line 1 in Table 5-2c.

Table 5-2c
Barstow – Interconnection Lines to the High Voltage Transmission Grid

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	***High***	***Low***	***High***	***Low***	***High***	***Low***	***High***
1	—	230 kV Connection T/L	—	124	—	147,840	—	421
2	230 kV Connection T/L	230 kV Connection T/L	124	224	89,760	26,400	256	136
3	230 kV Connection T/L	500 kV Connection T/L	124	724	110,880	95,040	316	1,580
4	500 kV Delivery T/L	500 kV Delivery T/L	224	224	374,880	374,880	1,928	1,928
Total	—	—	—	—	**575,520**	**644,160**	**2,500**	**4,065**

Table 5-2d
Barstow – Characteristics of Major Transmission Grid Upgrades

Substation Start and Points	Line No.	Voltage	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Low-Capacity Scenario	High-Capacity Scenario
New Substation nr. Pisgah Substation to Mira Loma	4	500 kV	Yes	Yes	98*	66	5	Yes	Yes

Note: *Pisgah–Mira Loma is 98 miles total but only 71 miles are inside of the DRECP boundary.

West Mojave

Due to the electrical complexity and size of the West Mojave RESA, it is split into three separate sub-areas for analysis: Tehachapi, Antelope–Vincent, and Lugo. Each sub-area has a specific set of assumptions relating to the renewable technology mix for both high and low scenarios (Table 5-3). Wind resources would all be located in the Tehachapi sub-area only. Distributed generation (DG) MW is assumed to be interconnected with the developed transmission/distribution system of the Antelope–Vincent and the Lugo sub-areas. DG is expected to supply the renewable power to meet the local load requirements in these sub-areas.

Table 5-3
West Mojave Sub-Area Assumptions MWs Split by Technology

Sub-Area Name	Generation Capacity (MW)		Technology Split (Low)			Technology Split (High)		
Scenario	***Low***	***High***	***Wind***	***Solar***	***DG***	***Wind***	***Solar***	***DG***
Tehachapi	3,883	12,341	2,069	1,814	0	9,960	2,381	—
Antelope–Vincent	1,250	3,853	0	911	339	—	2,895	958
Lugo	813	2,465	0	474	339	—	1,507	958

West Mojave (Tehachapi Sub-Area)

The Tehachapi sub-area runs from the northern end of the RESA as far south as Whirlwind substation. New major 500 kV transmission lines would run west towards Bakersfield and connect at Gregg and Gates substations providing the key linkage from the Plan Area to Northern California load centers. Further, new 500 kV lines would run to the south via the

Tehachapi lines to the Southern California load centers. The Tehachapi sub-area assumptions are given in Table 5-3. All wind in the West Mojave RESA was assumed to be located in this sub-area.

The Tehachapi sub-area would require two (low scenario) or three (high scenario) large super collector substations (Table 5-4a). The proportional split between large and small projects is based on the CAISO interconnection queues in SCE service territory and was assumed to be 58% large generation and 42% small generation. Consequently, more 230 kV transmission lines are required in the Tehachapi area than in other parts of the West Mojave RESA (Table 5-4b).

The Tehachapi sub-area is one of the most electrically complex. The low scenario assumes several large 230 kV gen-ties (Table 5-4b). The high-development scenario adds a third collector substation and reduces the need for long gen-ties (Table 5-4b), but requires additional 500 kV transmission line upgrades to enable interconnection of more generation from the additional super collector substation (Table 5-4c).

Major Delivery Line Upgrades from the Tehachapi Area

Low-Capacity Scenario

The low-capacity scenario would require a single new Windhub–Lighthipe 500 kV line and one single circuit 500 kV line between Midway and Whirlwind (Table 5-4d). A single 500 kV line from the existing Barren Ridge station to a substation near Vincent, and a single 500 kV line from the same substation to an existing substation in the LA Basin. (Table 5-4d). Upgrades are also needed on Path 15 and Path 66. These are described in Section 5.2.

High-Capacity Scenario

In addition to the low-capacity scenario requirements, the high-capacity scenario would require an additional single circuit 500 kV line connecting the Whirlwind to Midway substations, and two additional single circuit 500 kV lines connecting the Windhub to Gregg or Gates substations. The LA Basin would require an additional single circuit 500 kV line between Windhub and Pardee substations that, within the DRECP, would run parallel to the Windhub to Lighthipe line (Table 5-4d). All lines would need additional ROW and no lines in this part of the Plan Area would run in federal or BLM corridors.

Table 5-4a
Mojave (Tehachapi Sub-Area) – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*
500/220/66 kV	215	2	3	430	645
Total	—	—	—	**430**	**645**

Table 5-4b
Mojave (Tehachapi Sub-Area) – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Total Length (feet)		Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*	*Low*	*High*
Double Circuit Single Strung 66 kV	30	1	2	52,800	105,600	36	72
Double Circuit Double Strung 66 kV	30	8	25	422,400	1,320,000	291	909
Double Circuit Double Strung 230 kV	124	—	8	—	211,200	—	600
Double Circuit Single Strung 230 kV	124	1	—	95,040	—	271	
Double Circuit Single Strung 230 kV	124	2	—	63,360	—	180	—
Double Circuit Single Strung 230 kV	124	1	—	42,240	—	120	—
Total	—	—	—	**675,840**	**1,636,800**	**898**	**1,581**

Table 5-4c
West Mojave (Tehachapi Sub-Area) – Interconnection Lines to the High Voltage Transmission Grid

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1	—	500 kV Delivery T/L*	—	474	—	132,000		1,436
2	500 kV Delivery T/L	500 kV Delivery T/L	224	474	31,680	31,680	163	345
3	—	500 kV Connection T/L	124	474	—	15,840	—	172
4	—	500 kV Connection T/L	124	724	—	95,040	—	1,580
5	500 kV Loop In T/L	500 kV Loop In T/L	474	474	15,840	15,840	172	172

Table 5-4c
West Mojave (Tehachapi Sub-Area) – Interconnection Lines to the High Voltage Transmission Grid

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
6	500 kV Connection T/L	500 kV Connection T/L	224	474	95,040	142,560	489	1,551
7	500 kV Connection T/L	500 kV Connection T/L	724	474	58,080	121,440	965	1,321
8	500 kV Delivery T/L**	500 kV Delivery T/L***	224	474	153,120	153,120	787	1,666
9	500 kV Connection T/L	500 kV Connection T/L	224	224	322,080	322,080	1,634	1,634
10	500 kV Connection T/L	500 kV Connection T/L	224	224	227,040	227,040	1,168	1,168
Total	—	—	—	—	**902,880**	**1,256,640**	**5,378**	**11,045**

Notes: *Windhub to Gregg; **Windhub to Lighthipe; ***Windhub to Pardee.

Table 5-4d
Mojave (Tehachapi) – Characteristics of Major Grid Upgrades

Substation Start and Points	Line No.	Voltage (kV)	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Needed in Low-Capacity Scenario	Needed in High-Capacity Scenario
Windhub to Lighthipe #1	1	500	No	Yes	29	6	23	Yes	Yes
Windhub to Pardee #1	1	500	No	Yes	29	6	23	No	Yes
Whirlwind to Midway #1	3	500	No	Yes	6	3	3	Yes	Yes
Whirlwind to Midway #2	3	500	No	Yes	6	3	3	No	Yes
Wind hub to Gregg or Gates #1	1	500	No	No	25	21	4	No	Yes
Wind hub to Gregg or Gates #2	1	500	No	No	25	21	4	No	Yes
Barren Ridge to new substation	1	500	No	No	61	—	61	Yes	Yes
New substation to Existing LA substation	1	500	No	No	43	43	—	Yes	Yes

Mojave (Antelope–Vincent Sub-Area)

The Antelope–Vincent sub-area is in the center the West Mojave RESA. It runs from the Antelope substation, west of Lancaster, to about 25 miles east of the Vincent substation. Antelope and Vincent substations would be the main delivery points to the high-voltage transmission grid.

The Antelope–Vincent sub-area would require two (low scenario) or three (high scenario) collector substations (Table 5-5a). Large-scale development is assumed to be 100% solar (Table 5-3), with a 95%/5% small project to large project split. For the high-capacity scenario, 958 MW, and for the low-capacity scenario, 339 MW of DG is assumed in developed areas but will be absorbed by local load. Due to the high proportion of small-scale projects assumed for this area, all gen-tie lines would be low voltage 66 kV lines (Table 5-5b). Connector lines are required to loop in new substations but no additional grid re-enforcement would be required (Table 5-5c).

Major Delivery Line Upgrades from the Antelope–Vincent Sub-Area

Low-Capacity Scenario

For the low-capacity scenario, a new single circuit 500 kV line would be required from the Antelope to Mesa substations and a single 500 kV line would be required from the Antelope to Vincent substations (Table 5-5c). Lines are likely to parallel current transmission but would likely require an expansion of current ROW (Table 5-5d).

High-Capacity Scenario

No additional lines are required for the high-capacity scenario.

Table 5-5a
Mojave (Antelope–Vincent Sub-Area) – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***
220/66 kV	77	2	2	154	154
500/220/66 kV	215	0	1	—	215
Total	—	—	—	**154**	**369**

Table 5-5b
Mojave (Antelope–Vincent Sub-Area) – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Length (feet)	Length (feet)	Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*	*Low*	*High*
Double Circuit Single Strung 66 kV	30	—	2	—	105,600	—	72
Double Circuit Double Strung 66 kV	30	5	13	264,000	686,400	182	472
Double Circuit Single Strung 230 kV	124	—	1	—	36,960	—	105
Total	—	—	—	**264,000**	**828,960**	**182**	**649**

Table 5-5c
Mojave (Antelope–Vincent Sub-Area) – Interconnection Lines to the High Voltage Transmission Grid)

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1	230 kV Connection T/L	—	124	—	21,120	—	60	–
2	230 kV Connection T/L	230 kV Connection T/L	124	124	89,760	110,880	256	316
3	—	230 kV Connection T/L	—	124	—	26,400	—	75
4	500 kV Delivery T/L	500 kV Delivery T/L	224	224	100,320	100,320	516	516
5	500 kV Delivery T/L	500 kV Delivery T/L	224	224	95,040	95,040	489	489
6	500 kV Delivery T/L	500 kV Delivery T/L	224	224	269,280	269,280	1,385	1,385
Total	–	–	–	–	**575,520**	**601,920**	**2,706**	**2,781**

Table 5-5d
Antelope–Vincent Sub-Area – Characteristics of Major Transmission Grid Upgrades

Substation Start and Points	Line No.	Voltage (kV)	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW in DRECP	Miles High Bio Value	Miles Low Bio Value	Low-Capacity Scenario	High-Capacity Scenario
Antelope to Mesa	4	500	No	Yes	19	14	5	Yes	Yes
Antelope to Vincent	5	500	No	Yes	18	14	4	Yes	Yes
Devers to Vincent	6	500	No	Yes	51	40	11	Yes	Yes

Mojave (Lugo Sub-Area)

The Lugo sub-area is immediately to the east and west of Victorville. The primary delivery point to load would be via the Lugo substation. Both low and high scenarios would require two 220/66 kV substations (Table 5-6a). Large-scale development was assumed to be 100% solar (Table 5-3), 87% small and 13% large project, based on current Commission data (Commission 2011c). In the low-capacity scenario, 339 MW, and in the high-capacity scenario, 958 MW of DG was assumed to be in developed areas but likely would be absorbed by local load. Due to the high proportion of small-scale projects in this area, most gen-ties would be low voltage 66 kV transmission lines (Table 5-6b). Additional 230 kV lines would be required to interconnect new substations (Table 5-6c), but no additional system upgrades or reinforcements would be required. When comparing the connection and system upgrades for low and high scenarios, only the number of gen-ties required to interconnect generation increases.

Major Delivery Line Upgrades from the Lugo Sub-Area

Low-Capacity Scenario

The low-capacity scenario would require a single 500 kV line from a substation near Lugo to Vincent or a substation near Vincent. An additional DC delivery line from a DC converter station near the Lugo sub-area to a terminating DC converter station within the greater LA Basin in the south has been included, which also will assist in the delivery of this RESA output.

High-Capacity Scenario

No additional grid reinforcement is required to deliver power from the Lugo sub-area.

Table 5-6a
Mojave (Lugo Sub-Area) – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	*Low*	*High*	*Low*	*High*
220/66 kV	77	2	2	154	154
Total	—	—	—	**154**	**154**

Table 5-6b
Mojave (Lugo Sub-Area) – Collector Lines (Gen-Ties)

Collector line Size (kV)	ROW	Quantity		Length (feet)	Length (feet)	Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***	***Low***	***High***
Double Circuit Single Strung 66 kV	30	1	2	52,800	105,800	36	72
Double Circuit Double Strung 66 kV	30	2	6	105,600	316,800	72	218
Double Circuit Single Strung 230 kV	124	—	1	—	15,840	—	45
Total	—	—	—	**158,400**	**438,440**	**108**	**335**

Table 5-6c
Mojave (Lugo Sub-Area) – Interconnection Lines to the High Voltage Transmission Grid

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	***High***	***Low***	***High***	***Low***	***High***	***Low***	***High***
1	230 kV Connection T/L (NS#1* – Lugo)	230 kV Connection T/L	124	124	142,560	142,560	406	406
2	230 kV Connection T/L (NS#2* – Victor)	230 kV Connection T/L	124	124	58,080	58,080	165	165
3	230 kV Connection T/L (Victor – Lugo)	230 kV Connection T/L	124	124	58,080	58,080	165	165
4	500 kV Delivery T/L	500 kV delivery T/L	224	224	269,280	269,280	1,384	1,384
5	DC Delivery Line	DC Delivery Line	224	224	73,920	73,920	380	380
Total	—	—	—	—	**601,920**	**601,920**	**2,500**	**2,500**

Note: *NS = New collector substation.

Table 5-6d
West Mojave Lugo Sub-Area – Characteristics of Major Transmission Grid Upgrades

Substation Start and Points	Line No.	Voltage	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Low-Capacity Scenario	High-Capacity Scenario
Lugo area-Vincent area	4	500 kV	unknown	yes	51	10*	41*	Yes	Yes
DC converter station nr.Victorville/ Lugo to DC converter LA Basin	5	DC	unknown	yes	14	12	2	Yes	Yes

Note: *estimated length in high and low value areas.

Blythe

Based on the Commission proposed project tracking data (Commission 2011c), current proposed project size distribution is split 90% large (greater than100 MW) and 10% small (less than 100 MW) projects. Generation interconnection (gen-tie lines) are sized and split proportionately.

The Blythe RESA is estimated to require one (low scenario) or two (high scenario) new collector substations (Table 5-7a) plus the expansion of the Colorado River substation for the high generation scenario. The high proportion of large projects in the Blythe RESA results in few large 66 kV gen-ties and several longer 230 kV gen-ties that vary depending on the number of substations in each scenario (Table 5-7b).

Major Delivery Line Upgrades from the Blythe Area

Low-Capacity Scenario

No grid reinforcement or additional delivery lines are required for the low-capacity scenario.

High-Capacity Scenario

For the high-capacity scenario, a new single circuit 500 kV line would be required from the Colorado River to Devers substation (Table 5-7c). This line is likely to parallel current transmission but would likely require expansion of the current ROW (Table 5-5c).

Table 5-7a
Blythe - Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***
66 kV expansion to Colorado River	39	0	1	0	39
220/66 kV	77	1	1	77	77
500/230 kV	176	0	1	0	176
Total	—	—	—	**77**	**292**

Table 5-7b
Blythe – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Length (feet)	Length (feet)	Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***	***Low***	***High***
Double Circuit Single Strung 66 kV	30	1	2	52,800	105,800	36	73
Double Circuit Single Strung 230 kV	124	1	—	47,520	—	135	—
Double Circuit Single Strung 230 kV	124	—	1	—	63,360	—	180
Double Circuit Single Strung 230 kV	124	1	—	58,800	—	165	—
Double Circuit Single Strung 230 kV	124	—	1	—	21,120	—	60
Double Circuit Single Strung 230 kV	124	—	1	—	52,800	—	150
Total	—	—	—	**159,120**	**243,080**	**336**	**463**

Table 5-7c
Blythe – Connection Lines (Connection to Main Grid)

Line No.	Alignment Description		ROW Width (feet)		Total Length (feet)		ROW Acreage	
	Low	***High***	***Low***	***High***	***Low***	***High***	***Low***	***High***
1	230 kV Connection T/L	—	124	—	58,080	—	165	—
2	—	230 kV Connection T/L	—	124	—	132,000	—	376
3	—	230 kV Connection T/L	—	124	—	79,200	—	225
4	—	500 kV Delivery T/L*	—	224	—	264,000	—	1,358
Total	—	—	—	—	**58,080**	**475,200**	**165**	**1,959**

Note: *Devers - Colorado River #2 transmission line has 50 miles in DRECP territory.

Table 5-7d
Blythe – Characteristics of Major Transmission Grid Upgrades

Substation Start and Points	Line No.	Voltage	Within Existing Federal Corridor	New or Expansion of ROW Required	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Low-Capacity Scenario	High-Capacity Scenario
Devers – Colorado River	4	500	Yes	Yes	50	20	15	No	Yes

Imperial

The Imperial Valley RESA was assumed to be a mixture of solar and geothermal resources, with 40% projects being large-scale geothermal (greater 100 MW) and 50% being large-scale solar. The remaining 10% was assumed to be ground-mounted DG.

Geothermal development would likely be located in the known geothermal development areas along the Salton Sea and near existing geothermal plants to the south. The scenario includes an assessment of the Imperial Irrigation District's (IID's) transmission expansion plan for building a geothermal collector system. Geothermal resources would interconnect to the two proposed Salton Sea 1 and Salton Sea 2 substations (equivalent to 66/230 kV upgrades in footprint). The remaining 500 MW geothermal plant was anticipated to interconnect to the existing transmission line or to an existing gen-tie.

Solar development was analyzed in the low-value agricultural and suitable BLM lands nearest to existing transmission lines. Solar was assumed to be confined to low-value agricultural and suitable BLM lands, and would require upgrades to existing substations. Upgrades were predominantly described as 220/66 kV collector stations (Table 5-8a). The assumption that all projects would likely be large-scale developments was reflected in the predominately 200 kV gen-tie mix (Table 5-8b).

Reinforcement of the IID transmission grid would be required under both low and high development scenarios as reflected in the high number of 230 kV connection lines (Table 5-8c).

Major Delivery Line Upgrades from the Imperial Area

Low-Capacity Scenario

Two single 500 kV lines running north from IID's Midway to Devers substations would be required and a single 500 kV line from IID Midway to Imperial Valley substation. A single 500 kV line from the Imperial Valley substation west to San Diego would be required.

Upgrades between the 230 kV Coachella Valley to Devers substations and various 230 kV upgrades between IID Midway/Bannister/El Centro/Highline to Imperial Valley substations would be required to maintain system integrity (Table 5-8d).

High-Capacity Scenario

In addition to the lines described in the low-capacity scenario, the high-capacity scenario would require an additional single 500 kV line from IID's Midway to Devers; an additional 500 kV line to San Diego from Imperial Valley substation; and an additional 500 kV line from Midway (IID) to Imperial Valley Substation. In addition, further upgrades to the 230 kV lines between the Coachella Valley and Devers substations would be required.

Table 5-8a
Imperial – Substations

Substation Size	Acreage	Quantity		Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***
Upgrade	20	1	1	20	20
220/66 kV	77	6	7	462	539
500/230 kV	176	2	2	352	352
Total Impacted Acreage	—	—	—	**834**	**911**

Table 5-8b
Imperial – Collector Lines (Gen-Ties)

Collector Line Size (kV)	ROW (feet)	Quantity		Length (feet)	Length (feet)	Total Acreage Impact	
Scenario	—	***Low***	***High***	***Low***	***High***	***Low***	***High***
Single circuit 230 kV	124	2	4	21,120	42,240	60	120
Single circuit 230 kV	124	4	5	63,360	79,200	180	225
Single circuit 230 kV	124	1	3	26,400	79,200	75	225
Single circuit 230 kV	124	1	1	42,240	42,240	120	120
Single circuit 230 kV	124	1	1	52,800	52,800	150	150
Single circuit 230 kV	124	1	1	95,040	95,040	270	270
Total	—	—	—	**300,960**	**390,720**	**855**	**1,110**

Table 5-8c
Imperial – Connection Lines (Connection to Main Grid)

Line No.	Alignment Description		ROW Width (feet)*		Total Length (feet)		ROW Acreage	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
1	500 kV Delivery T/L	500 kV Delivery T/L	474	724	116,160	116,160	1264	1931
2	500 kV Delivery T/L	500 kV Delivery T/L	250	475	316,800	316,800	1455	1455
3	230 kV Connection T/L	230 kV Connection T/L	124	124	31,680	31,680	90	90
4	—	230 kV Connection T/L	—	124	—	73,920	—	210
5	230 kV Connection T/L	230 kV Connection T/L	124	124	84,480	84,480	240	240
6	230 kV Connection T/L	230 kV Connection T/L	124	124	100,320	100,320	286	286
7	230 kV Connection T/L	230 kV Connection T/L	124	124	89,760	89,760	144	144
8	230 kV Connection T/L	230 kV Connection T/L	124	124	5,280	5,280	18	18
9	230 kV Connection T/L	230 kV Connection T/L	124	124	132,000	132,000	212	212
10	230 kV Connection T/L	230 kV Connection T/L	—	124	—	84,480	—	136
11	230 kV Connection T/L	230 kV Connection T/L	124	194	79,200	79,200	225	225
12	230 kV Connection T/L	230 kV Connection T/L	124	194	42,240	42,240	120	120
13	500 kV Delivery T/L	500 kV Delivery T/L	224	474	126,720	126,720	651	1376
Total	—	—	—	—	**1,124,640**	**1,283,040**	**4,705**	**6,443**

Note: *ROW widths provided by IID.

Table 5-8d
Imperial – Characteristics of Major Grid Upgrades

Substation Start and Points	Voltage (kV)	Within Existing Federal Corridor	Expansion of Existing ROW	Miles ROW	Miles High Bio Value	Miles Low Bio Value	Low-Capacity scenario	High-Capacity scenario
Midway (IID) to Devers #1	500	Yes (partially)	Yes	90	—	22	Yes	Yes
Midway (IID) to Devers #2	500	Yes (partially)	Yes	90	—	22	Yes	Yes
Midway (IID) to Devers #3	500	Yes (partially)	Yes	90	—	22	No	Yes
Midway (IID) to Imperial Valley #1	500	No	Yes	60	—	60	Yes	Yes
Midway (IID) to Imperial Valley #2	500	No	Yes	60	—	60	No	Yes
Imperial Valley to Sycamore #1	500	Yes (partially)	Yes	94	24	—	Yes	Yes
Imperial Valley to Sycamore #2	500	Yes (partially)	Yes	94	24	—	Yes	Yes
Coachella Valley to Ramon/Mirage (Path 42)	230	No	Yes	20	—	—	Yes	Yes
Ramon/Mirage to Devers (SCE's Path 42)	230	No	Yes	15	—	—	Yes	Yes

Summary of Effects

The total estimated linear effects and affected acreages for substations, gen-ties, and connector and delivery lines for each RESA is given in Table 5-9, along with the percentage of the RESA that is of high biological value.

Table 5-9
RESAs – Total Impacts

RESA	Transmission Component	Linear ROW Feet		Percentage High Biological Value Area in RESA	Total Acreage Impacts from Transmission Components	
	Scenario	*Low*	*High*		*Low*	*High*
Owens Valley	Substation	—	—	90%	77	77
	Gen-Tie	158,400	211,200		223	259
	Collection/Delivery	448,800	448,800		1,030	1,030

Table 5-9
RESAs – Total Impacts

RESA	Transmission Component	Linear ROW Feet		Percentage High Biological Value Area in RESA	Total Acreage Impacts from Transmission Components	
	Scenario	*Low*	*High*		*Low*	*High*
Barstow	Substation	—	—	60 %	330	545
	Gen-Tie	496,320	871,200		615	656
	Collection/Delivery	575,520	644,160		2,500	4,065
West Mojave Tehachapi	Substation	—	—	40%	430	645
	Gen-Tie	675,840	1,636,800		898	1,581
	Collection/Delivery	902,880	1,256,640		5,378	11,045
West Mojave Antelope-Vincent	Substation	—	—	5%	154	369
	Gen-Tie	264,000	828,960		182	649
	Collection/Delivery	575,520	601,920		2,706	2,781
West Mojave Lugo	Substation	—	—	20%	154	154
	Gen-Tie	158,400	438,440		108	335
	Collection/Delivery	601,920	601,920		2,500	2,500
Blythe	Substation	—	—	30%	77	292
	Gen-Tie	159,120	243,080		336	463
	Collection/Delivery	58,080	475,200		165	1,959
Imperial	Substation	—	—	10%	834	911
	Gen-Tie	300,960	390,720		855	1110
	Collection/Delivery	1,124,640	1,283,040		4,705	6,443
Total	**Substation Impacts**	**—**	**—**	**—**	**2,056**	**2,993**
	Gen Tie Impacts	**2,213,040**	**4,620,400**	**—**	**3,217**	**5,053**
	Collection/Delivery	**4,287,360**	**5,311,680**	**—**	**18,984**	**29,823**

5.2 Delivery Lines Assessment for Bulk Transmission Upgrades

This section further summarizes the upgrades necessary for both the low- and the high-capacity scenarios. For each upgrade, the total mileage of the upgrade both inside and outside of the DRECP, along with the mileage within the DRECP, is described. Within the DRECP, the mileage is further divided into approximate distances within moderate to high biological value areas and distance within low biological value areas (based on the PCS [Commission 2011a]). Where a transmission line could be identified as being within either a federal 368 or BLM energy corridor for at least part of its distance this is noted. Finally, where the line is likely to need additional ROW, this is also identified. The locations of the upgrades within the RESA are presented in Figure 2.

The delivery lines are defined as the bulk transmission upgrades to California's high-voltage transmission grid system that may be required to enable delivery from the RESAs to serve customer load. The methods and intermediate steps used to determine the number of delivery lines needed for each RESA are presented in Appendix A.

Conceptual Delivery Lines in the Low-Capacity Scenario

The low-capacity scenario can be characterized as requiring transmission upgrades to support and deliver renewable resources to the major load centers in San Diego, the LA Basin, and Northern California. Table 5-10 identifies the necessary major transmission upgrades that would be necessary to deliver to major load areas, including to areas in Northern California that are outside the Plan Area.

Table 5-10
Major Transmission Upgrades Required for the Low-Capacity Scenario

Substation Start and Points	Voltage (kV)	Within Existing Federal Corridor	Expansion of Existing ROW	Total Miles ROW	Miles ROW in DRECP	Miles High Bio Value	Miles Low Bio Value
Imperial Valley Substation to San Diego							
Imperial Valley to Sycamore #1	500	Yes (partially)	—	94	24	0	24
Imperial Valley IID System to the North and South							
Midway (IID) to Devers #1	500	Yes (partially)	Yes	90	22	0	22
Midway (IID) to Devers #2	500	Yes (partially)	Yes	90	22	0	22
Midway (IID) to Imperial Valley #1	500	No	Yes	60	60	0	60
Coachella Valley to Ramon/Mirage (Path 42)	230	No	Yes	20	0	-	-
Ramon/Mirage to Devers (SCE's Path 42)	230	No	Yes	15	0	-	-
Imperial Valley North-Devers to LA Basin and to send renewables to Northern CA and NW							
Devers to Vincent #1	500	No	Yes	117	51	40	11
Devers to Rancho Vista #1	500	No	Yes	60	-	-	-
Barstow and West Mojave to LA Basin							
Pisgah to Mira Loma #1	500	Yes	Yes	—	97	60	7
Antelope to Mesa #1	500	No	Yes	—	14	14	4

Table 5-10
Major Transmission Upgrades Required for the Low-Capacity Scenario

Substation Start and Points	Voltage (kV)	Within Existing Federal Corridor	Expansion of Existing ROW	Total Miles ROW	Miles ROW in DRECP	Miles High Bio Value	Miles Low Bio Value
Antelope to Vincent #1	500	No	Yes	—	14	14	4
Windhub to Lighthipe #1	500	No	Yes	99	29	6	23
New Owens Valley Substation to Barren Ridge	230	Yes	Yes	—	85	78	7
Barren Ridge to New Substation	500	Partially	No	61	61	0	61
New Substation to existing substation in LA Basin	500	No	No	43	0	43	0
Substation near Victorville/Lugo to Vincent to LA Basin	500	No	Yes	51	51	0	51
DC converter station nr.Victorville/Lugo to DC converter LA Basin (proposed DC)	500	No	No	40	14	2	12
Mojave to Northern California and to PNW							
Path 26 Whirlwind to Midway #1	500	No	Yes	70	6	3	3
Path 15 Midway – Tesla/Tracy #1	500	—	—	210	—	—	—
Path 15 Midway – Tesla /Tracy #2	500	—	—	210	—	—	—

Conceptual Delivery Lines in the High-Capacity Scenario

The high-capacity scenario describes the transmission required in **addition** to that described in the low scenario. Many of the additional transmission requirements reinforce the needs identified in the low-capacity scenario, by doubling or tripling the capacity of particular corridors (Table 5-11). However, the upgrades identified from the LA Basin to the Mojave RESA (Table 5-11) would be required to enable the energy to flow around the LA Basin and on to Northern California because there would be insufficient load within Southern California to make effective use of new generation resources from both the Imperial and Mojave RESAs (Figure 2).

Table 5-11
Major Transmission Upgrades Required for the High-Capacity Scenario

Substation Start and Points	Voltage (kV)	Within Existing Federal Corridor	Expansion of Existing ROW	Total Miles ROW	Miles ROW in DRECP	Miles High Bio Value	Miles Low Bio Value
Imperial Valley Substation West to San Diego							
Imperial Valley to Sycamore #2	500	Yes (partially)	—	94	24	0	24
Imperial Valley IID System to the North and South							
Midway (IID) to Devers #3	500	Yes (partially)	Yes	90	22	0	22
Midway (IID) to Imperial Valley #2	500	No	Yes	60	60	0	60
Imperial Valley North-Devers to LA Basin (also to send renewables to Northern CA and NW)							
Devers- Lugo #1	500	No	Yes	70	4	4	0
Blythe to LA Basin							
Colorado River to Valley #2 (DCR 2)	500	Yes	Yes	155	52	49	33
Mojave to LA Basin							
Windhub to Pardee #1	500	No	Yes	50	29	6	23
Mojave to Northern California and to PNW							
Path 26 Whirlwind to Midway #2	500	No	Yes	70	6	3	3
Path 26 Windhub to Gregg #1	500	No	No	180	25	21	4
Path 26 Windhub to Gregg #2	500	No	No	180	25	21	4
Path 15 Gregg – Tesla/Tracy #1	500	—	—	145	—	—	—
Path 15 Gregg – Tesla #2	500	—	—	145	—	—	—
Path 15 Midway – Tesla/Tracy #3	500	—	—	210	—	—	—
Path 66 Tesla/ Tracy - Malin / Captain Jack #1	500	—	—	320	—	—	—
Path 66 Tesla/Tracy – Malin / Captain Jack #2	500	—	—	320	—	—	—

Figure 1 – Schematic representation of major transmission infrastructure upgrades within the Plan Area identified in the low-capacity scenario.

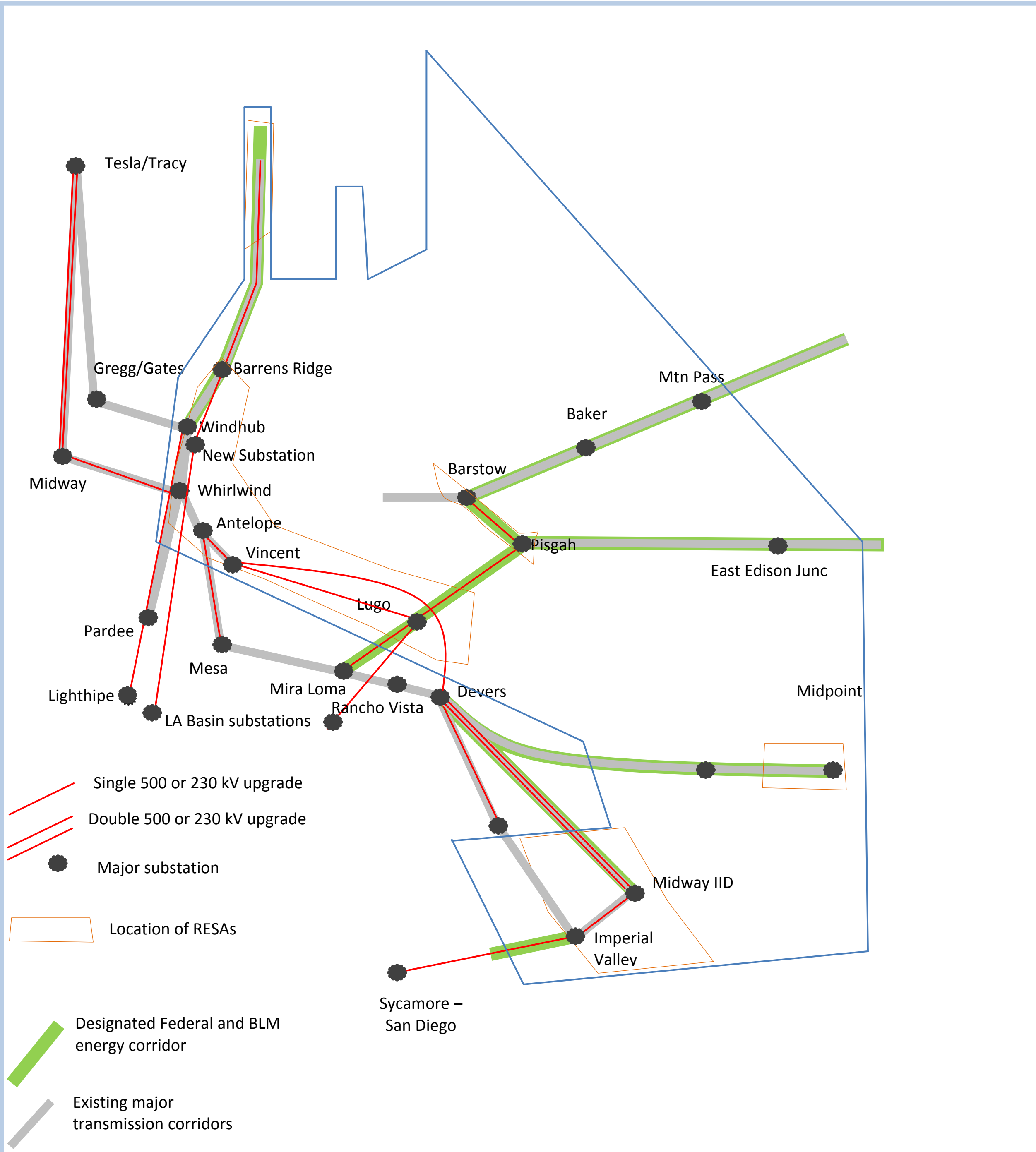
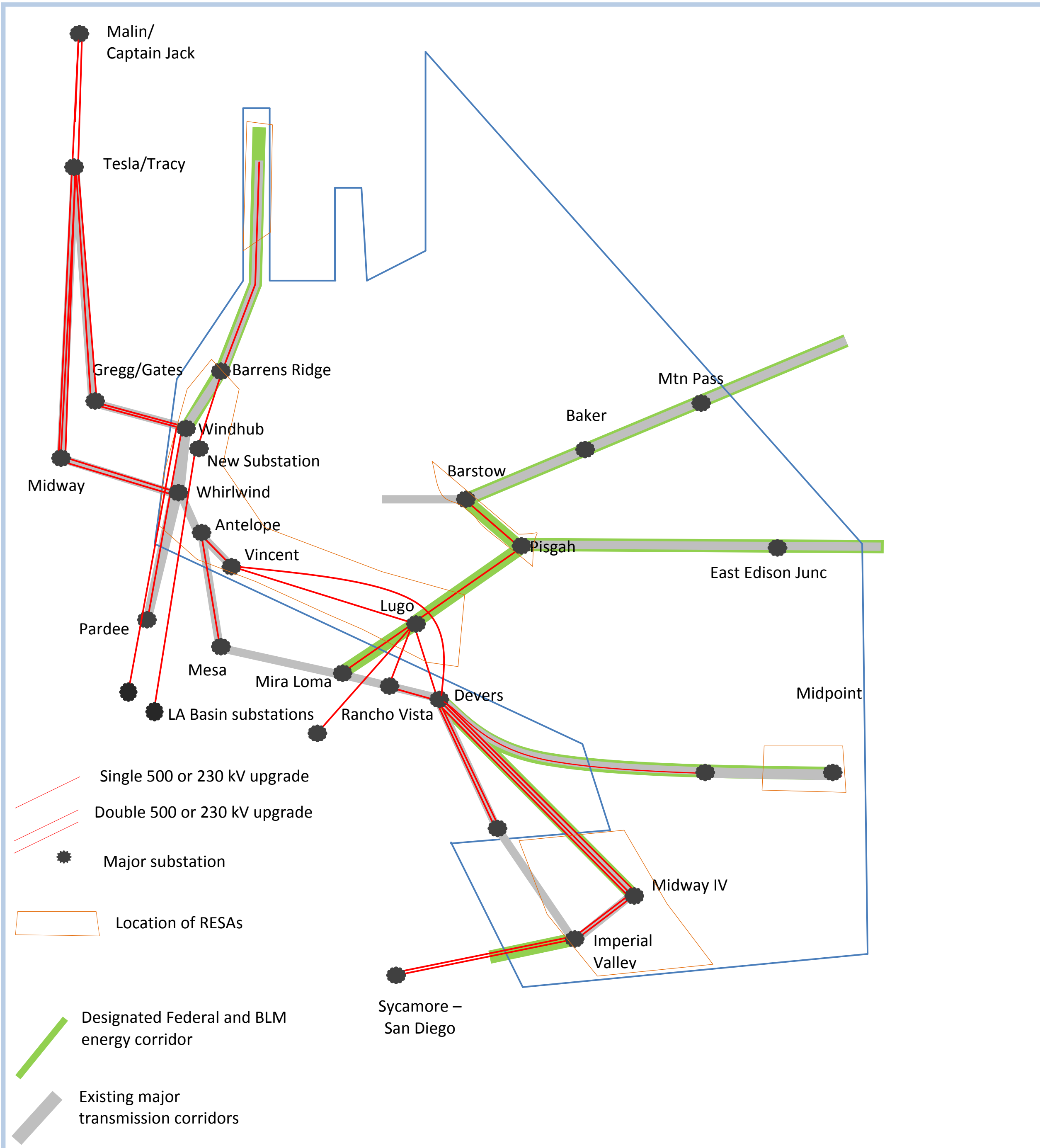


Figure 2 – Schematic representation of major transmission infrastructure upgrades within the Plan Area identified in the high-capacity scenario.



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APPENDIX A

Capacity Calculations for Estimating Bulk Transmission Requirements

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

The delivery lines are defined as the bulk transmission upgrades to California's high-voltage transmission grid system needed to deliver energy from the RESAs to serve customer load. In order to calculate the renewables capacity (MW) to be delivered from each RESA, a set of tables (Tables A-1 through A-5 with the results presented in Tables 5-10 and 5-11 in the body of this memo) were developed as described in the following steps:

Step 1: Table A-1 presents the determination of maximum simultaneous output of renewable MW at each RESA.

Table A-1 represents the adjusted renewable MW for maximum simultaneous renewable output for an hour during the annual generation output cycle within each RESA location. The data in columns labeled (1) and (2) of this table were populated by utilizing the available adjusted RESA MW for the 2040 low acreage and 2050 high acreage cases for each RESA location from Table 4-1 above, columns (3) and (6). This data was further adjusted by Maximum Simultaneous Output percentages shown in the column labeled (3) for each renewable technology type for all RESAs.

The CTPG has established that the Hour Ending 14 during the month of April represents the maximum simultaneous renewable output at any given renewable zone based on its annual renewable production cycle hourly data for each renewable technology type. The DRECP TTG has utilized and applied the percentage values to the total installed capacity of renewable resource at each RESA based on that RESA's specific renewable output profiles to generate the maximum simultaneous renewable output for each RESA following the CTPG methodology.

Columns labeled (4) and (5) in the table represent the maximum simultaneous RESA output values of renewable MW available for delivery lines for the 2040 low acreage and 2050 high acreage at each RESA location. These adjusted MW values were derived after a percent adjustment applied to the respective renewable MW values in columns labeled (1) and (2). The table shows the renewable MW available at all RESAs are reduced for the low scenario from 15,172 to 12,215 MW and for the high scenario from 34,107 to 24,655 MW complying with the CTPG methodology noted above.

Step 2: Tables A-2 and A-3 present allocation of maximum simultaneous renewable output of each RESA under low and high acreage scenarios among buyers in various regions and determination of total "Delivery MW" with addition of pre-RESA CTPG flow amounts.

Tables A-2 and A-3 represent the allocation of the maximum simultaneous RESA MW for the low scenario and high scenario respectively with equal portion of these renewable MW being delivered to each of the four selected regions, i.e., Southern California (25%), Northern California (25%), PNW (25%), and southwest buyers (25%).

The allocated MW data is shown under columns labeled (2), (3), and (4) in three sets of aggregated data values representing the first set (25% each) going to Southern California and southwest buyers, the second set (50%) going to Northern California and PNW buyers, and the third set (75%) going west from all RESAs for delivery to Southern California, Northern California, and PNW buyers.

The column labeled (5) represents the pre-RESA flows in MW on the existing and new bulk power delivery transmission lines under construction (pre-RESA delivery network as of 2020) and capable of delivering some of each RESA's output with any spare capacity, if available. Since all proposed DRECP new delivery transmission lines will be an integral part of California's transmission grid network along with the pre-RESA existing and approved new transmission lines under construction, it is important to add the pre-RESA power flows to the RESA renewable outputs to determine the total delivery needs from each RESA location. Column (6) represents the sum of the CTPG pre-RESA flows and RESA renewable outputs for the 75% set of MW data going west (Southern California, Northern California, and PNW combined) from each RESA location.

The data values for pre-RESA power flows (MW) on the pre-RESA transmission network (existing and approved new lines under construction up to year 2020) were obtained from the CTPG Foundation Spring '0' Case power flow database and are shown in Column (5) for each RESA location and are named as "Pre-RESA Flow from CTPG Spring '0' Case."

Step 3: Tables A-4 and A-5 presents the determination of new delivery transmission lines for RESA renewables.

Tables A-4 and A-5 represent the final set of calculations to determine the RESA renewable MW delivery amounts in MW associated with each RESA and identification of the new transmission delivery lines under the low and high scenarios, respectively. The table is further divided in two parts: (A) MW values of 75% for all RESAs flowing west except West Mojave, which shows MW value of 25% going west to Southern California, and (B) MW values of 50% of all RESAs going to Northern California plus PNW buyers.

Data under column (1) represent values for the sum of RESA MW plus Pre-RESA CTPG Flow for all RESA locations, and under column (2) represent the CTPG pre-RESA flows utilizing the existing transmission capacity. Subtracting column (2) from column (1) provides the remaining Balance of RESA MWs in column (3), which requires new delivery lines. Using an industry standard of up to 1,200 MW of transmission capacity for a typical 500 kV line, the number of the required new delivery lines for delivering each RESA's renewable outputs to the buyers in various load centers is noted under column (4) for each RESA. The new delivery lines are described from their starting substation to the terminating substation. The termination substation may change in the future based on the load growth pattern changes, new reliability requirements, magnitude, location, and timing of renewable generation development levels, renewable generation development in new non-RESA locations and its size by target years 2040 and 2050.

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-1
High and Low RESA Renewable Scenarios — Adjusted MW for Maximum Simultaneous Renewable Output

RESA	Technology	Adjusted RESA MW for Collector Lines (From Table 4-1, Cols. 3 and 6		Maximum Simultaneous Output (%) from RESA Renewables* (3)	RESA MW For Delivery Lines with Simultaneous Output % Applied	
		Adjusted 2040 Low Acreage (1)	Adjusted 2050 High Acreage (2)		Adjusted 2040 Low Acreage (4)	Adjusted 2050 High Acreage (5)
Barstow	Solar	836	1,252	85%	711	1,064
	Wind	540	1,838	34%	184	625
	DG	177	353	90%	159	318
	Subtotal =	***1,553***	***3,443***	—	***1,054***	***2,007***
Blythe	Solar	806	1,388	85%	685	1,180
	DG	168	87	90%	151	78
	Subtotal =	***974***	***1,475***	—	***836***	***1,258***
Imperial	Geothermal	2,529	3,582	90%	2,276	3,224
	Solar	3,101	4,934	88%	2,729	4,342
	DG	656	1,393	90%	590	1,254
	Subtotal =	***6,286***	***9,909***	—	***5,595***	***8,819***
Owens Valley	Solar	414	621	90%	373	559
West Mojave	Solar	3,199	6,783	90%	2,879	6,105
	Wind	2,069	9,960	42%	869	4,183
	DG	677	1,916	90%	609	1,724
	Subtotal =	***5,945***	***18,659***	—	***4,357***	***12,012***
	Total	**15,172**	**34,107**	—	**12,215**	**24,656**

Note: * For Hour Ending 14 during April (Spring Case).

Table A-2

Low Acreage RESA MW Adjusted for Maximum Simultaneous Renewable Output % Plus CTPG Pre-RESA MW Flow Amount and its Allocation among WECC Area Utilities for Delivery **

RESA	Technology	Maximum Simultaneous Output MW for 2040 Low Acreage Scenario [from Table A-1, Col. (4) (1)	25% Share of MW Each going to Southern CA and also going East to SW Utilities (2) = [25% of MW in (1)]	50% Share of MW for Northern CA and NW Utilities combined (All going North To PG&E) (3) = [50% of MW in (1)]	75% Share of MW for Southern CA, Northern CA, NW Utilities combined Total Going West) (4) = [75% of MW in (1)]	Pre-RESA Flow from CTPG Spring '0' Case in MW (5)	75% Renewables RESA MW plus Pre-RESA CTPG Flow Going West (All CA plus NW utilities) (6) = Sum of [(4) + (5)] Note: Calcs. For West Mojave shown separately in two parts below in the last two rows
Barstow***	Solar	711	178	356	533	—	—
	Wind	184	46	92	138	—	—
	DG	159	40	80	119	—	—
	Subtotal =	***1,054***	***264***	***527***	***791***	***2,579***	***3,370***
Blythe	Solar	685	171	343	514	—	—
	DG	151	38	76	113	—	—
	Subtotal =	***836***	***209***	***418***	***627***	***1,251***	***1,878***
Imperial	Geothermal	2,276	569	1,138	1,707	—	—
	Solar	2,729	682	1,365	2,047	—	—
	DG	590	148	295	443	—	—
	Subtotal =	***5,595***	***1,399***	***2,798***	***4,196***	***1,545***	***5,741***
Owens Valley	Solar	373	93	187	280	350	630
West Mojave	Solar	2,879	720	1,440	2,159	—	—
	Wind	869	217	435	652	—	—
	DG	609	152	305	457	—	—
	Subtotal =	***4,357***	***1,089***	***2,179***	***3,268***		***3,268***

Appendix A

Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-2

Low Acreage RESA MW Adjusted for Maximum Simultaneous Renewable Output % Plus CTPG Pre-RESA MW Flow Amount and its Allocation among WECC Area Utilities for Delivery **

RESA	Technology	Maximum Simultaneous Output MW for 2040 Low Acreage Scenario [from Table A-1, Col. (4) (1)	25% Share of MW Each going to Southern CA and also going East to SW Utilities (2) = [25% of MW in (1)]	50% Share of MW for Northern CA and NW Utilities combined (All going North To PG&E) (3) = [50% of MW in (1)]	75% Share of MW for Southern CA, Northern CA, NW Utilities combined Total Going West) (4) = [75% of MW in (1)]	Pre-RESA Flow from CTPG Spring '0' Case in MW (5)	75% Renewables RESA MW plus Pre-RESA CTPG Flow Going West (All CA plus NW utilities) (6) = Sum of [(4) + (5)] <u>Note</u>: Calcs. For West Mojave shown separately in two parts below in the last two rows
West Mojave CTPG Pre-RESA Flow to So. CA	—	—	1,089	—	—	2,553	3,642
West Mojave CTPG Pre-RESA Flow to PG&E and NW ****	—	—	—	2,179	—	-3,631	-1,453
	Total	**12,215**	**3,054**	**6,108**	**9,161**	**—**	**—**

Notes:

** RESA Renewables off-set fossil generation decrements and/or load growth in all four regions, i.e., Southern CA, Northern CA, Desert SW, and PNW utilities with each region receiving 25% of the Total RESA MW pool.

*** Added 75% of Ivanpah (non-RESA renewable under construction) into the Barstow Pre-RESA CTPG Flow amount in first row value under Col. labeled (5) - CTPG did not include Ivanpah Gen.

**** Includes Pacific Intertie DC Line Pre-RESA CTPG Spring Case '0' Flow under Col. labeled (5).

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-3
High Acreage RESA MW Adjusted for Maximum Simultaneous Renewable Output % Plus CTPG Pre-RESA MW Flow Amount and its Allocation among WECC Area Utilities for Delivery **

RESA	Technology	Maximum Simultaneous Output MW for 2050 High Acreage Scenario [from Table A-1, Col. (5)] (1)	25% Share of MW Each going to Southern CA and also going East to SW Utilities (2) = [25% of MW in (1)]	50% Share of MW for Northern CA and NW Utilities combined (All going North To PG&E) (3) = [50% of MW in (1)]	75% Share of MW for Southern CA, Northern CA, NW Utilities combined (Total Going West) (4) = [75% of MW in (1)]	Pre-RESA Flow from CTPG Spring '0' Case in MW (5)	75% Renewables RESA MW plus Pre-RESA CTPG Flow Going West (All CA plus NW utilities) (6) = Sum of [(4) + (5)] <u>Note</u>: Calcs. For West Mojave shown separately in two parts below in the last two rows
Barstow***	Solar	1,064	266	532	798	—	—
	Wind	625	156	313	469	—	—
	DG	318	80	159	239	—	—
	Subtotal =	***2,007***	***502***	***1,004***	***1,505***	***2,579***	***4,084***
Blythe	Solar	1,180	295	590	885	—	—
	DG	78	20	39	59	—	—
	Subtotal =	***1,258***	***315***	***629***	***944***	***1,251***	***2,195***
Imperial	Geothermal	3,224	806	1,612	2,418	—	—
	Solar	4,342	1,086	2,171	3,257	—	—
	DG	1,254	314	627	941	—	—
	Subtotal =	***8,819***	***2,205***	***4,410***	***6,614***	***1,545***	***8,159***
Owens Valley	Solar	559	140	280	419	350	769
West Mojave	Solar	6,105	1,526	3,053	4,579	—	—
	Wind	4,183	1,046	2,092	3,137	—	—
	DG	1,724	431	862	1,293	—	—
	Subtotal =	***12,012***	***3,003***	***6,006***	***9,009***	***—***	***9,009***
West Mojave	—	—	3,003	—	—	2,553	5,556

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-3
High Acreage RESA MW Adjusted for Maximum Simultaneous Renewable Output % Plus CTPG Pre-RESA MW Flow Amount and its Allocation among WECC Area Utilities for Delivery **

RESA	Technology	Maximum Simultaneous Output MW for 2050 High Acreage Scenario [from Table A-1, Col. (5)] (1)	25% Share of MW Each going to Southern CA and also going East to SW Utilities (2) = [25% of MW in (1)]	50% Share of MW for Northern CA and NW Utilities combined (All going North To PG&E) (3) = [50% of MW in (1)]	75% Share of MW for Southern CA, Northern CA, NW Utilities combined (Total Going West) (4) = [75% of MW in (1)]	Pre-RESA Flow from CTPG Spring '0' Case in MW (5)	75% Renewables RESA MW plus Pre-RESA CTPG Flow Going West (All CA plus NW utilities) (6) = Sum of [(4) + (5)] Note: Calcs. For West Mojave shown separately in two parts below in the last two rows
CTPG Pre-RESA Flow to So. CA							
West Mojave CTPG Pre-RESA Flow to PG&E and NW ****	—	—		6,006	—	-3,631	2,375
	Total	**24,655**	**6,164**	**12,328**	**18,491**	**—**	**—**

Notes:
** RESA Renewables off-set fossil generation decrements and/or load growth in all four regions i.e., Southern CA, Northern CA, Desert SW, and PNW utilities with each region receiving 25% of the Total RESA MW pool.
*** Added 75% of Ivanpah (non-RESA renewable under construction) into Barstow Pre-RESA CTPG Flow amount in first row value under Col. Labeled (5) - CTPG did not include Ivanpah.
**** Includes Pacific Intertie DC Line Pre-RESA CTPG Spring Case '0' Flow under Col. Labeled (5).

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-4
Low Acreage RESA MW – Determination of New Delivery Transmission Lines for RESA Renewables

Area Being Served by RESA	RESA Renewables + Pre-RESA CTPG Flow [From Table A-2, Col. (6)] (1)	Existing Transmission Capacity (2)	(RESA + Pre-RESA CTPG Flow MW) - Existing Capacity = Remaining MW needing New Transmission (3)=(1)-(2)	Determination of New Delivery Lines[5] (4)
(A) To Southern CA (@75% of RESA share except West Mojave @25%)				
From Barstow	3,370	2,754	616	1- 500 kV Line Pisgah to Lugo / Mira Loma plus LADWP proposed 500 kV upgrades
From Blythe	1,878	1,802	76	No new line needed
From Imperial	5,741	2,184	3,557	2-500kV lines from Devers to Vincent and Rancho Vista 500kV substations plus IID Coachella to Devers 230kV Upgrades and 1-500kV line from Imperial Valley 500kV Substation to Sycamore Substation (SDG&E) Plus IID proposed 230kV and 500kVlines within Imperial Valley to deliver Imperial RESA MW
From Owens Valley	630	440	190	230kV proposed upgrade by LADWP
From West Mojave (So. CA 25% Share only)	3,642	0	3,642	3 - 500kV lines to LA Basin consisting of: 1 Antelope - Mesa, 1 Antelope - Vincent and 1 Windhub - Lighthipe 500kV lines Plus LADWP proposed 500kV and DC Upgrades to deliver to LA Basin

[5] 1 – 500kV circuit = 1200 - 1500 MW capacity range.

Appendix A
Capacity Calculations for Estimating Bulk Transmission Requirements

Table A-4
Low Acreage RESA MW – Determination of New Delivery Transmission Lines for RESA Renewables

Area Being Served by RESA	RESA Renewables + Pre-RESA CTPG Flow [From Table A-2, Col. (6)] (1)	Existing Transmission Capacity (2)	(RESA + Pre-RESA CTPG Flow MW) - Existing Capacity = Remaining MW needing New Transmission (3)=(1)-(2)	Determination of New Delivery Lines[5] (4)
(B) To Northern CA + NW (50% of All RESA Share under Fall Conditions[6])				
Path 26 RESA Delivery on this path 5,233[7] - 1,250[8] = 3,983 (northbound)	3,983 + 300 = 4,283	3000	1283	1 - Whirlwind-Midway 500 kV line
Path 15 RESA Delivery on this path 5,233 – 1,250 = 3,983 (northbound)	3,983 + 3,650 = 7,633	5000	2633	2 - Midway-Tesla/Tracy 500 kV lines [9, 10]
Path 66 RESA Delivery on this path 2,616[11] - 1,250 = 1,366 (northbound)	1366 + 1750 = 3116	3675	<0	—

[6] Fall conditions were found to be most limiting for northbound deliveries to Northern California and the Northwest.

[7] Includes the Northern California and the Northwest shares of RESA, as follows: Barstow share (464 MW) , Blythe Share (1549 MW), Imperial Share (1422 MW), Owens Valley Share (168 MW), West Mojave Share (1631 MW).

[8] Available PDCI Capacity per CTPG Fall "0" case to be used for RESA deliveries to the PNW.

[9] Project is expected to include a Gates-Gregg transmission line.

[10] This project is consistent with the Midway-Gregg--Tesla/Tracy 500 kV line which was identified as a potential project in its 2011 study.

[11] Includes NW share only.

Table A-5
High Acreage RESA MW - Determination of new Delivery transmission lines for RESA Renewables

Area Being served by RESA	RESA Renewables + Pre-RESA CTPG Flow [From Table A-3, Col. (6)] (1)	Existing Transmission Capacity (2)	(RESA + Pre-RESA CTPG Flow MW) - Existing Capacity = Remaining MW needing New Transmission (3)=(1)-(2)	Determination of New Delivery Lines[12] (4)
(A) To Southern CA (@75% of RESA share except West Mojave @25%)				
From Barstow	4,084	2,754	1,330	1-500kV Line Pisgah to Lugo + LADWP proposed upgrades
From Blythe	2,195	1,800	395	1-500kV Line Valley - Colorado River (DCR #2) line needed
From Imperial	8,159	2,184	5,975	3-500kV lines from Devers to Lugo, Vincent and Rancho Vista 500kV substations plus IID Coachella to Devers 230kV Upgrades and 2-500kV lines from Imperial Valley 500kV Substation to Sycamore Substation (SDG&E) Plus IID proposed 230kV and 500kV lines within Imperial Valley to deliver Imperial RESA MW
From Owens Valley	769	440	329	230kV proposed upgrade by LADWP
From West Mojave (So. CA 25% Share only)	5,556	0	5,556	4 - 500kV lines to LA Basin consisting of: 1 Antelope - Mesa, 1 Antelope - Vincent, 1 Windhub - Lighthipe, and 1 Windhub - Pardee 500kV lines Plus LADWP proposed 500kV and DC Upgrades to deliver to LA Basin

[12] 1-500kV circuit = 1200 - 1500 MW capacity range.

Table A-5
High Acreage RESA MW - Determination of new Delivery transmission lines for RESA Renewables

Area Being served by RESA	RESA Renewables + Pre-RESA CTPG Flow [From Table A-3, Col. (6)] (1)	Existing Transmission Capacity (2)	(RESA + Pre-RESA CTPG Flow MW) - Existing Capacity = Remaining MW needing New Transmission (3)=(1)-(2)	Determination of New Delivery Lines[12] (4)
(B) To Northern CA + NW (50% of All RESA Share under Fall Conditions)[13]				
Path 26 RESA Delivery on this path 9782[14] - 1250[15] = 8532 (northbound)	8532 + 300 = 8832	3000	5832	• 2 - Whirlwind-Midway 500 kV lines • 2 - Windhub-Gregg 500 kV lines
Path 15 RESA Delivery on this path 9782 - 1250 = 8532 (northbound)	8532 + 3650 = 12182	5000	7182	• 3 - Midway-Tesla/Tracy 500 kV lines • 2 – Gregg-Tesla/Tracy 500 kV lines
Path 66 RESA Delivery on this path 4891[16] - 1250 = 3641 (northbound)	3641 + 1750 = 5391	3675	1716	• 2 - Tesla/Tracy-Malin/ Captain Jack 500 kV lines

[13] Fall conditions were found to be most limiting for northbound deliveries to Northern California and the Northwest.
[14] Includes the Northern California and the Northwest shares of RESA, as follows: Barstow share (798 MW) , Blythe Share (,2239 MW), Imperial Share (2,401 MW), Owens Valley Share (252 MW), West Mojave Share (4093 MW).
[15] Available PDCI Capacity per CTPG Fall "0" case to be used for RESA deliveries to the PNW.
[16] Includes NW share only.