Appendix K

Transmission Technical Group Report

DRECP
Transmission Technical Group Report

Conceptual Transmission Plan for DRECP Alternatives

October 2013

Note to Readers

The Transmission Technical Group Report was completed in the fall of 2013, before the alternatives were made public with the release of the Draft EIR/EIS. In order to complete this report, it was necessary to share the DRECP alternatives with the Transmission Technical Group. However, to minimize information shared about the alternatives, they were only identified by number. As a result, for this report, Alternative 5 corresponds with the Preferred Alternative identified elsewhere in the EIR/EIS.

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Important Definitions

This report uses several terms that are critical to the reader's understanding of the document's conclusions. They are defined here:

- **Collector Lines** – Collector lines are used to connect generation projects to collector substations. Depending on the size of the generation project, these lines can be 34.5 kV, 66 kV, or 230 kV. Collector lines are sometimes called generator interconnection lines, or "gen-tie" lines.
- **Collector Substations** – These substations are the receiving points for generation. They could accept Collector Lines (gen-ties) at 66 kV, 230 kV, or 500 kV or they could serve multiple voltages. The largest of these substations are called "super collector substations."
- **Connector Lines** – These lines connect lower voltage substations (e.g., the 230/66 kV collector substations) with the higher voltage substations (e.g., the 500/230 kV collector substations). Connector lines can also connect large substations (e.g., 500 kV substations).

  Delivery Lines – These 500 kV (AC or DC) and 230 kV (AC) transmission lines are used as delivery lines. Delivery lines would connect collector substations or super collector substations with the major grid substations and support the bulk power transfer of electricity between generation centers and load centers. In this analysis, delivery lines usually cross the DRECP Plan Area boundary, or are completely outside of the DRECP area.

Note to Readers

Section 4.5 of this report identifies specific new transmission line segments that would be needed to accommodate renewable energy generation that could be developed in each DRECP alternative. The voltage and approximate locations of new transmission lines are included for each DRECP alternative and shown in the maps presented at the end of this report. The length and voltage of the lines have been defined as a means of calculating the impact acreage (both within and outside of the DRECP Plan Area) so impacts can be evaluated in the EIR/EIS that will be prepared for the DRECP.

This is a conceptual transmission plan for the alternatives and is not intended to be a siting exercise. Thus, the line segments represent only the electrical connections (i.e., the end-points of line segments) and do not reflect specific siting plans or routes. However, the Garamendi principles were used when constructing these maps and thus the lines were drawn to follow existing rights-of-way wherever possible. The new transmission lines identified through this exercise have not been evaluated for their specific locations, constructability, desirability, cost, or likelihood of their successful permitting. They also have not been studied by transmission planning groups to identify reliability concerns or effects on other transmission systems.

The extent of potential transmission concerns for each alternative will be considered by the Renewable Energy Action Team in its selection of the preferred alternative for development within the DRECP Plan Area.

The conceptual transmission plan and associated acres of impact defined in this report are based on the professional judgment of experienced transmission planners representing the major utilities from across the state. Transmission lines that are approved or under construction (i.e., the Devers-Colorado River Project, Tehachapi Renewable Transmission Project, and Barren Ridge Transmission Project) are assumed to provide some capacity for renewable projects permitted through the DRECP, but these lines are not included on the alternative maps; **only new transmission lines are shown on the maps.**

Transmission Serving DRECP Alternatives

1. Executive Summary

In January of 2012, the REAT agencies created the Transmission Technical Group (TTG) to develop conceptual information about the transmission additions likely to be required to serve renewable energy development in the Desert Renewable Energy Conservation Plan (DRECP). In April 2012, the TTG completed a report called *Transmission Impacts in the DRECP.*[1] This report described the transmission additions that could be required to develop generalized Renewable Energy Study Areas (RESAs). The report provided linear distances and affected acreages that could be affected by new substations, generation tie-lines, and connector and delivery transmission lines required to serve each RESA.

Subsequent to the April 2012 report (and a corrected version released in June 2012), the RESA approach was modified based on field reconnaissance data from the Renewable Energy Action Team (REAT) agencies along with stakeholder input. The result is a more refined alternatives concept in which development is concentrated in smaller and more numerous "Development Focus Areas (DFAs)." The DFAs represent the areas within which permitting of renewable energy development would be streamlined under the DRECP. DFAs (and the amount of generation) within each alternative differ. The acreage of DFAs for each EIR/EIS alternative ranges from approximately 1.07 and 2.48 million acres.

In late 2012, the TTG analyzed 5 alternatives that incorporated varying assumptions about development within each DFA. This analysis was released in conjunction with the *Description and Comparative Evaluation of Draft DRECP Alternatives*[2] (December 2012), which was intended to provide stakeholders and the public a chance to review and provide feedback on plan alternatives. In the December 2012 report (see Appendix 1), although the DRECP alternatives were based on approximately 20,000[3] megawatts (MW) of renewable generation, the TTG assumed a need for new transmission to serve about 14,000[4] MW for all alternatives. The results presented in the December 2012 report were as complete as possible for the alternatives as described at that time and presented the additional transmission components that could be necessary to connect the renewable generators in each DFA to a collector substation, and the transmission that could connect the collector substations to bulk transmission that would facilitate the delivery of the renewable power to loads. The impacts of all transmission facilities (presented as acres affected) associated with each alternative were estimated based on the length of new transmission lines, using a formula for width of rights-of-way for transmission lines and substations.

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1 Available at: http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/Transmission_Technical_Group_report_final_4_16_12.pdf

2 Available at: http://www.drecp.org/documents/docs/alternatives_eval/Appendices/Appendix_A_TTG_Report.pdf

3 The MW Total was rounded from 20,323 to 20,000 in recognition of the general programmatic nature of the planning effort.

4 The TTG assumed some recently approved new lines (operating and under construction) would provide approximately 7,500 MW of capacity for new renewable generation projects including: Sunrise Powerlink Project (1,200 MW), Tehachapi Renewable Transmission Project (4,500 MW), Barren Ridge Renewable Transmission Project (1,200 MW), and Devers-Colorado River Project (600 MW). As such, the TTG assumed the need for new transmission to serve about 14,000 MW: 20,000 MW (-) 7,500 MW for new lines and (+) 1,500 MW for DOD = 14,000 MW.

The December 2012 alternatives document was published in order to get feedback from the public regarding alternative approaches for renewable energy siting and conservation. The alternatives have been revised in response to this feedback, new data, and REAT agencies' input. The TTG was asked to review and assess the revised alternatives and determine any transmission infrastructure land impact acreage changes to the December 2012 conceptual transmission plan. The revised alternatives resulted in changes in transmission infrastructure needs and associated land acreage impacts based on the latest revisions to the overall level of generation by each renewable technology, and the renewable generation that could be located in individual DFAs. The TTG was also asked to evaluate Alternative 4 and the No Action Alternative that were not considered in the December 2012 TTG Report.[5]

This report presents the results of the most recent TTG work. After reviewing the DFAs in the 2013 alternatives, their geographical locations and the renewable generation changes, the TTG noted that the total renewable generation for each revised alternative preserved the total renewables at approximately 20,000 MW, similar to the December 2012 alternatives.[6] However, the amount of renewable generation within each DFA under all alternatives varies compared to the December 2012 alternatives. This data analysis led the TTG team to develop a transmission land impact acreage methodology utilizing a simplified approach based on the assessment of renewable generation dispersion overall and within each DFA under all alternatives.[7] The results were further adjusted to account for the renewable generation MW changes within each specific DFA for all 2013 alternatives based on the December 2012 TTG transmission land impact acreages while also accounting for any resulting increase or decrease in transmission infrastructure within each DFA under each revised alternative. This allowed the TTG to build on the information it had previously developed, rather than recreating a new transmission plan and developing associated land acreage impact calculations from scratch.

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[5] The DRECP assumed that the No Action Alternative would still develop about 20,000 MW of renewable energy. As with the action alternatives, the No Action Alternative, described in Section II.2 of the DRECP EIR/EIS, assumes that the State will achieve its renewable energy goals in support of greenhouse gas (GHG) reduction targets. It further assumes that the contribution of the Plan area to the State goals would be similar to the preferred and other alternatives.

[6] The December 2012 Alternatives 1, 2, 3, 5, and 6 were evaluated by the TTG and data for each was presented in that report. The REPG did not request the TTG to analyze Alternative 4 because of the similarities that the REPG saw between that alternative and Alternative 2 and because Alternative 4 was added after the TTG had completed its work. The set of alternatives (prior to the December 2012 Report) included an earlier version of Alternative 4, which focused renewable development in Imperial County. This alternative which included 14,000 MW of renewable energy in Imperial County in addition to associated transmission was eliminated from consideration by the TTG and the REAT agencies because it would most likely have required significant new fossil-fuel generation within Imperial County to support the integration of 14,000 MW of renewable generation, in addition to the transmission and substation acreage impacts. The December 2012 Report included an Alternative 4 that replaced the earlier eliminated version that focused 14,000 MW in Imperial Valley. The second Alternative 4 was not evaluated by the TTG as mentioned above.

[7] The dispersion approach used by the TTG employs a calculated land impact acreage factor (Acres/MW: total transmission impact in acres divided by renewable MW) based on total renewable generation under each alternative with additional adjustment to account for differences in total renewable generation within each DFA between December 2012 and revised 2013 alternatives and the associated transmission land impact acres for each DFA taken from the December 2012 calculations. The calculated transmission land impact factor (Acres/MW) is applied to the revised 2013 alternatives' overall renewable generation amount and is further adjusted for each DFAs' renewable generation amounts to determine the new transmission land impact acreages.

The information presented in this report has been developed solely for the purpose of defining the approximate area (in acres) that would be impacted by transmission facilities that are likely to be required for each of the EIR/EIS alternatives. This effort is not intended to identify specific new transmission lines or routes, or to replace the utilities' transmission planning processes, which would normally include power flow studies and stability studies. The conceptual transmission plan and associated acres of impact are based on the professional judgment of experienced transmission planners representing the major utilities from across the state.

Assumptions

The study retains the basic assumption from the December 2012 report: a combination of available and new transmission capacity would be utilized to accommodate generation within the DFAs out to 2040.[8] As presented in the December 2012 report, this Report assumed that the availability of existing transmission was based on the 2020 pre-renewable cases[9] prepared by the California Transmission Planning Group (CTPG).[10] The underlying assumption is that in the years leading up to 2040 transmission additions 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 availability of existing transmission capacity in 2040.

The renewable energy estimated to be generated from within the DFAs is assumed to displace less efficient thermal generation that has higher variable operating costs throughout the WECC region in the following distribution:

- 25% of displaced thermal generation would be from gas-fired generators in Southern California;
- 25% of displaced thermal generation would be from gas-fired generators in Northern California;
- 25% of displaced thermal generation would be from gas-fired generators in the Pacific Northwest (PNW); and
- 25% of the displaced thermal generation would be from gas-fired generators in the states of the desert Southwest (SW), including Arizona, Nevada, and New Mexico.

The TTG did not address any transmission that could be built on the Department of Defense (DOD) lands. Instead, the Department of Defense provided exit point locations at the base boundaries for 1,500 MW and the TTG planned for collector lines to the nearest collector substations. For this analysis and at the DOD's request, this 1,500 MW was in addition to the 20,000 MW of renewable generation included in each of the DRECP alternatives.

The TTG identified transmission system facility additions that would accommodate a specified number of megawatts of renewable generation that could be developed in the DFAs by 2040. The basic assumptions used to define impacts of transmission components remain the same as with the December 2012 report and include an assumed capacity (in MW) and an associated acreage of land that

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[8] The April/June 2012 TTG Report assumed phased transmission development to accommodate both 2040 and 2050 generation projections. In October 2012, the TTG was tasked to focus on analyzing only the transmission additions required to transport the renewable energy necessary to meet 2040 projections and this assumption also applies to 2013 alternatives transmission assessment.

[9] The CTPG pre-renewable cases were developed in 2011 and model 2020 spring, 2020 summer, and 2020 fall conditions and establish the flows that are assumed for 2040 prior to dispatching the renewable generation assumed to be located within the RESAs.

[10] http://www.ctpg.us/

would be impacted by the construction and operation of each element. The amount and location of renewable generation in DFAs has been revised since the December 2012 report and is different for each alternative.

Dispersion Methodology

The TTG used the conceptual transmission plan land impact acreage results from the December 2012 report to calculate the transmission acreage impacts for the revised 2013 alternatives. The TTG assessed the overall renewable generation for its dispersion within each DFA and among all DFAs, the predominant renewable technology type, the transmission land impact acreages, and the evaluation of delivery lines to load centers for each alternative for the December 2012 and the revised 2013 alternatives.

This approach, called the dispersion methodology allowed the December 2012 report to be revised and updated rather than producing an entirely new evaluation for the October 2013 report. The dispersion methodology compared the geographical dispersion of MW within the DRECP with the range of renewable generation MW by technology (e.g., solar, wind , etc.) for each set of alternatives (December 2012 and October 2013) and calculated the difference. (See Figure ES-1 below)

Figure ES-1 illustrates the range in MW for solar and wind generation for the December 2012 alternatives and the Revised 2013 alternatives. This figure also provides the calculated delta values which represent the difference in the spread (maximum minus minimum values of the range) for the solar and wind generation for December 2012 alternatives and the revised 2013 alternatives. The delta numbers are identical within the December 2012 and 2013 alternatives for solar and wind resources and fairly close in comparison to each other. The Geothermal and the DG renewable generation MW are constant at 2,800 MW and 2,417 MW respectively under the old and revised alternatives. As such, it can be concluded that the slight changes in the amounts of solar and wind resources under the old and revised alternatives occur on a small scale. These changes indicate a methodology based on the set of acreage impacts would be appropriate.

Similarly, when looking at the range of generation acres and its calculated delta values in Figure ES-1, these numbers remain very similar in magnitude under the old and the revised alternatives. This further substantiates that the acreages for the solar and wind generation have changed by small amounts under both sets of the December 2012 and the revised 2013 alternatives as a result of the relatively small increase expected in solar and similarly small decrease in wind development.

Based on a comprehensive assessment, the TTG utilized a renewable dispersion measurement methodology to calculate a conversion factor (Transmission impact in Acres/MW) for each alternative based on the December 2012 results and applied it to the revised 2013 renewable generation MW for each alternative and its associated DFAs to derive the total transmission land impact acreage for that alternative for the new 2013 conceptual transmission plan.

Figure ES-1. Comparative Assessment of MW and Associated Generation Acreage Ranges under December 2012 and Revised 2013 DRECP Alternatives by Renewable Technologies

Type of Renewable Technology	Range of Renewable MW				Range of Generation Acres			
	Dec. 2012 Alts.	Calculated Delta	New Alternatives	Calculated Delta	Dec. 2012 Alts.	Calculated Delta	New Alternatives	Calculated Delta
Solar	8,449 - 14,135	5,686	9,296 - 14,708	5412	59,988 - 100,359	40,371	66,002 - 104,430	38,428
Wind	971 - 6,657	5,686	398- 5,810	5412	38,840 - 266,280	227,440	15,901- 232,400	216,499
Geothermal	2,800	0	2,800	0	14,000	0	14,000	0
DG	2,417	0	2,417	0	17,161	0	17,161	0

Key Observations:

1. Calculated Delta between December 2012 and Revised 2013 Alternatives MW data ranges have not changed by any appreciable amounts and are similar in values by renewable technology types under both sets of December 2012 and revised 2013 Alternatives.

2. Similarly, the calculated Delta between December 2012 and Revised 2013 Alternatives' Generation impacted acreages values ranges have not changed by any appreciable amounts and are similar in values by renewable technology types compared to the December 2012 Alternatives and revised 2013 Alternatives.

3. Geothermal and DG MW and associated Impacted Generation Acreages remain the same under the December 2012 and the Revised 2013 Alternatives

The resulting transmission land impact acreages were further adjusted for the variations of renewable generation in each DFA and the relocation of renewable generation among DFAs to account for any increase or decrease in transmission infrastructure acreages within each DFA. (See Figure ES-2 below.) Because the acreage of transmission effects depends in large part on the length of transmission lines, the new TTG methodology accounts for each alternative's overall renewable generation as well as a DFA specific adjustment for transmission length to be incorporated in the calculation of total transmission land impact acreages. The increase or decrease in MW for each ecoregion was multiplied by an acreage/MW factor calculated by the TTG using the December 2012 data and the result was used to adjust the overall transmission land impact acreage results to account for the DFA specific differences in renewable generation MW.

As Alternative 4 and the No Action Alternative were not analyzed in the December 2012 TTG report, the data provided for the other alternatives, with comparable levels of MW in DFAs, assessed in December 2012 were used as proxy for these two alternatives. This was deemed appropriate because the MW and location of the MW allocated for these two alternatives were within the range of MW allocated for the alternatives considered in the December 2012 TTG report. The TTG reviewed the acreage and locations of the delivery lines and ensured that they remained appropriate to transfer the revised levels of renewable generation MW overall and for the specific DFAs in each new alternative developed within the DRECP.

Figure ES-2. Example of Renewable Resources Relocation among Ecoregions and Acreage Adjustment Evaluation for DFA Specific Dispersion for Alternative 5

Alternative 5	New MW	Dec MW	Dec Transmission Acreage	Acreage/ MW	New MW-Dec MW	Additional Acreage
Cadiz Valley and Chocolate Mountains	4,934	2,081	1,797	1.21	2853	3462
Imperial Borrego Valley	7,156	7,643	9,687	1.50	(487)	(732)
Kingston and Funeral Mountains	419	199	0	0.00	220	0
Mojave and Silurian Valley	410	983	4,136	2.79	(573)	(1598)
Owens River Valley	299	173	593	3.43	126	432
Panamint Death Valley	0	51	316	6.20	(51)	(316)
Pinto Lucerne Valley and Eastern Slope	1,669	1,773	743	0.42	(104)	(44)
Piute Valley and Sacramento Mountair	0	0	0	0.00	0	0
Providence and Bullion Mountains	166	0	0	0.00	166	0
West Mojave and Eastern Slopes	5,270	7,420	2,605	1.12	(2150)	(2414)
Total	20,323	20,323	20,192		0	(1210)

Figure ES-2 shows that while some of the MWs moved from one DFA to another when comparing the December 2012 alternatives to the revised 2013 alternatives, overall there was no change in total renewable MWs from December 2012 to October 2013. The use of this information is explained in more detail under 4.3 Dispersion Methodology for DFA Analysis, in seven key steps (on page 22).

Results

The transmission plan land impact acreages for each ecoregion under each alternative for the revised 2013 alternatives are calculated utilizing the dispersion methodology described earlier and are presented in Table ES-1. Table ES-1 also summarizes the total transmission system land impact acreage for each alternative evaluated by the TTG. This transmission land impact acreage ranges from a low of

29,944 acres to a high of 35,574 within the DRECP map area boundary and are very small when compared to the overall acreage inside the DRECP, about 22.5 million acres. The results also prove that these transmission land impact acreage values under the revised 2013 alternatives have not changed much when compared to those corresponding to the December 2012 alternatives, further validating the selected approach and application of the dispersion methodology to reflect the differences in generation MW values and generation acreages between the two sets of old and revised alternatives.

Table ES-1. Acreage of Impacts per Ecoregion for each DRECP Alternative[11]

Ecoregion	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	No Action Alternative
Cadiz Valley and Chocolate Mountains	7,316	8,490	7,502	18,130	12,911	14,375
Imperial Borrego Valley	16,073	14,449	13,915	6,429	12,253	12,116
Kingston and Funeral Mountains	0	716	0	188	914	0
Mojave and Silurian Valley	1,883	1,429	1,095	455	386	2,431
Owens River Valley	2,165	739	828	917	431	0
Panamint Death Valley	0	42	607	243	0	0
Pinto Lucerne Valley and Eastern Slopes	4,214	6,000	4,803	2,062	3,595	645
Piute Valley and Sacramento Mountains	0	0	0	0	0	0
Providence and Bullion Mountains	637	1,181	718	314	362	1,152
West Mojave and Eastern Slopes	1,467	1,169	2,360	1,206	1,796	4,854
Total Inside DRECP	33,755	34,214	31,828	29,944	32,648	35,574
Total Outside DRECP	32,495	31,656	32,495	31,656	29,095	31,656

[11] The TTG had originally used other nomenclature to identify the general geographic regions where the DFAs were clustered. The ecoregions presented in this report correspond with those used to calculate the transmission acreage impacts used in the December 2012 report as follows and were based off of the U.S. Forest Service National Hierarchical Framework adopted by the Forest Service Ecological Classification and Mapping Task Team. Please see further explanation on page 10 of this report, particularly footnote 14.

The transmission acreage of land impacts presented in Table ES-1 includes ***only*** the new acreage required to carry the renewable energy from the location of generation to the load centers under the revised 2013 alternatives. It does not include any acreage of impacts for the already-approved new transmission lines that are assumed to be operational and under construction in the TTG scenario, and that support the interconnection and transfer of 7,500 MW of renewable resource development within the DFAs to load centers. These lines include the Sunrise Powerlink, Tehachapi Renewable Transmission Project, Devers-Colorado River Project, and the Barren Ridge Renewable Transmission Project.

2. Introduction and Background

2.1 DRECP Background

The Desert Renewable Energy Conservation Plan (DRECP) is a proposed multi-species Land Use Plan Amendment (LUPA)/Natural Community Conservation Plan (NCCP)/Habitat Conservation Plan (HCP) 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.

The DRECP is being developed by the following federal and state agencies in California: The Bureau of Land Management (BLM), United States Fish and Wildlife Service (USFWS), California Energy Commission (CEC), and California Department of Fish and Wildlife (CDFW). These agencies form California's Renewable Energy Action Team (REAT). The REAT was formed by an Executive Order (S-14-08[12]) in order to streamline permit review and approval timeframes for renewable energy projects and to recommend impact avoidance measures or alternatives when appropriate. Additional federal and state agencies participate in DRECP direction, including the California Independent System Operator (CAISO), California Public Utilities Commission (CPUC), California State Lands Commission (CSLC), the National Park Service, Department of Defense, Department of the Interior, and the U.S. Environmental Protection Agency.

2.2 Purpose of the DRECP's Transmission Technical Group

In January of 2012, the REAT agencies created the Transmission Technical Group (TTG) to develop conceptual information about the transmission additions likely to be required to serve renewable energy development in the DRECP. The co-chairs of the TTG are staff members from the Energy Commission, CAISO, and CPUC. Utility participants include the Southern California Edison Company (SCE), Imperial Irrigation District (IID), Los Angeles Department of Water and Power (LADWP), Pacific Gas and Electric Company (PG&E), and San Diego Gas and Electric Company (SDG&E).

The purpose of this report is to provide input for impact analysis of the transmission associated with the alternatives evaluated in the Draft DRECP and Draft EIR/EIS, specifically focusing on the land use impacts (acres of land disturbance) that would occur due to electric transmission system additions that would support the transport of electricity generated for each alternative to load. This report incorporates the results of the December 2012 report and adjusts them using a conversion factor and adjustment for length of transmission line. This report estimates the acreage of transmission system impact for each alternative, allowing analysis of the impacts of both generation and transmission in the Draft EIR/EIS. The information presented in this report has been developed solely for the purpose of defining approximate impact acreage for transmission that could be associated with the alternatives considered in the Draft DRECP and Draft EIR/EIS. This effort is not intended to identify specific new transmission lines, identify specific routes, or to replace the utilities' transmission planning processes. This analysis is also neutral regarding ownership of generation projects and transmission facilities.

[12] The Executive Order is available at http://gov.ca.gov/news.php?id=11072

2.3 TTG Initial Reports

The "Preliminary Conservation Strategy" for the DRECP published July 10, 2011 and updated in October 2011,[13] identified five areas where renewable energy projects were expected to be concentrated. Those areas were called Renewable Energy Study Areas (RESAs); they were identified based on consideration of their available renewable energy resources and the likelihood of lower biological conflict areas. In April 2012, the TTG published an initial report called *Transmission Impacts in the DRECP.*[14] This report described the transmission additions that could be associated with the development of renewable resources in the RESAs.

The development scenario was generated based on the data from the Energy Commission's Renewable Energy Acreage Calculator (Calculator).[15] 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. 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 were then converted into MW, using specific land use requirements for each technology (e.g., geothermal requires 5 acres/MW, while wind requires 40 acres/MW). These values, expressed in MW 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 used only the 2040 estimates for this latest report.

While the TTG was preparing the initial report that was issued in April 2012, the RESA approach was modified and a development scenario based on a more refined concept in which development is concentrated in smaller and more numerous "Development Focus Areas (DFAs)." The DFAs represent the areas within which permitting of renewable energy development would be streamlined under the DRECP. This change in approach (from RESAs to DFAs) led to a second round of analysis by the TTG which was presented in the December 2012 report (see Appendix 1)[16]. The December 2012 report included 6 alternatives and the No Action Alternative that incorporate varying assumptions about development within each DFA. The TTG analyzed 5 due to the late addition of the sixth alternative and the No Action Alternative.

The TTG report assumes new transmission that will support the development of about 14,000 MW for all alternatives. Several already-approved new transmission lines are assumed to be operational or under construction in the TTG scenario, and they support another 7,500 MW of renewable resource development within the DFAs. These lines include the Sunrise Powerlink, Tehachapi Renewable Transmission Project, Devers-Colorado River Project, and the Barren Ridge Renewable Transmission Project.

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13 http://www.drecp.org/documents/docs/preliminary_conservation_strategy/index.php

14 Available at: http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/Transmission_Technical_Group_report_final_4_16_12.pdf

15 http://www.drecp.org/meetings/2011-12-05_meeting/presentations/

16 For more information about the Renewable Energy Development Scenarios see the presentations available for the April 25 and 26, 2012 DRECP Stakeholder Committee Meeting at: http://www.drecp.org/meetings/2012-04-25-26_meeting/presentations/

2.4 October 2013 Alternative Revisions

Since December 2012, the REAT agencies have reviewed and revised the DRECP alternatives based on comments on the *Description and Comparative Evaluation of Draft DRECP Alternatives*. The revisions include updated DFAs and revised MW distribution throughout the DRECP. The alternatives presented in this report correspond with those of the December 2012 report as follows:

Revised October 2013 Alternatives	Equivalent Alternatives in December 2012 Report	Description of Change
■ Alternative 1	■ Alternative 1	■ Minor changes to DFAs and MW distribution
■ Alternative 2	■ Alternative 3 and Alternative 5	■ The DFAs presented in the December 2012 report in Alternatives 3 and 5 have been combined into one alternative in the current version of the DRECP EIR/EIS alternatives, called Alternative 2. Although the DFAs presented in the current Alternative 2 combine both those from the December 2012 Alternative 3 and Alternative 5, the MW associated with the current Alternative 2 are distributed similarly to those assigned to the December 2012 Alternative 5.
■ Alternative 3	■ Alternative 4 and Alternative 1	■ The TTG did not analyze Alternative 4 in the December 2012 report as the alternative was not final in time for the TTG review. In order to analyze the current Alternative 3, the TTG compared the DFA locations and the MW to the other alternatives and found that Alternative 3 was substantially similar to the December 2012 Alternative 1 which was used as a model for the current Alternative 3 conversion factor.
■ Alternative 4	■ Alternative 6	■ Minor changes to DFAs and MW distribution
■ Alternative 5	■ Alternative 2	■ Minor changes to DFAs and MW distribution
■ No Action Alternative	■ No Action Alternative and Alternative 5	■ The TTG did not analyze the No Action Alternative in the December 2012 report as the alternative was not final in time for the TTG review. In order to analyze the current No Action Alternative, the TTG compared the DFA locations and the MW to the other alternatives and found that it was substantially similar to the December 2012 Alternative 5 which was used as a model for the conversion factor.

3. Assumptions for Conceptual Transmission Analysis to Support Renewable Resource Development within DFAs

In this report, the TTG used the same acreage assumptions as those identified in the December 2012 report for the transmission system facility additions. Each new element of the transmission system (e.g., substation, transmission line) has an assumed capacity (in MW) to accommodate generation, and an associated amount of land that would be impacted by its construction and operation. For example, the TTG agreed to use a value of 77 acres of land for a 230/66-kilovolt (kV) substation in the December 2012 report and those assumptions hold true for this report as well. The TTG compiled the transmission system additions by defining transmission components to match the renewable generation capacity for each DFA. The transmission additions described herein include connector transmission lines and substations, as well as the collector lines (also known as radial generation tie lines, or gen-tie lines) and delivery lines that would connect and facilitate delivery of renewable energy projects to load centers.

3.1 Estimating Transmission Capacity Requirements for Each Alternative

In order to identify a conceptual transmission plan, the TTG developed a set of assumptions. The study assumes that a combination of available existing transmission capacity and new transmission capacity would be utilized to accommodate generation development within the DFAs. The availability of existing transmission capacity in 2040 was assumed to be as indicated by the 2020 pre-renewable cases prepared by the CTPG. The underlying assumption is that in the years leading up to 2040, transmission additions 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 availability of existing transmission capacity in 2040.

The DRECP team developed the alternative scenarios for renewable development in DFAs. The generation targets for the alternatives are about 20,000 MW with an assumed mixture of solar, wind, and geothermal generation technologies. To ensure that existing transmission plans were accounted for, the TTG planners subtracted from the renewable transmission requirements the transfer capability of known collector facilities and approved delivery line projects that are currently under construction or recently became operational. These lines are assumed to provide approximately 7,500 MW of capacity for new renewable generation projects and are the following:

- Sunrise Powerlink Project (1,200 MW) is a single circuit 500 kV line from the Imperial Valley Substation to the new Suncrest Substation, and a double-circuit 230 kV line from the Suncrest Substation to the Sycamore Substation.
- Tehachapi Renewable Transmission Project (4,500 MW), includes a series of transmission system improvements to deliver electricity from new wind energy projects in eastern Kern County to the Los Angeles Basin. The project includes a number of new and upgraded 220 kV and 500 kV transmission facilities and substations.
- Barren Ridge Renewable Transmission Project (1,200 MW) is a double-circuit 230 kV transmission line from the Barren Ridge Switching Station in Kern County to the Haskell Canyon Switching Station in Los Angeles County.
- Devers-Colorado River Project (600 MW) consists of three new components: Colorado River 500 kV Switching Station, Devers-Valley 500 kV transmission line, and Colorado River-Devers 500 kV transmission line).

The distribution of renewable generation technologies is DFA-specific and alternative-specific. The conceptual transmission plan for each alternative assumes that all generation is online within each DFA by 2040. After publication of the December 2012 report, the distribution of MW was revised slightly (see Appendix O). The distribution of MW used by the TTG in this report is presented in Tables 3-1 through 3-6 by ecoregion.[17] The TTG had originally used other nomenclature to identify the general geographic regions where the DFAs were clustered. The ecoregions presented in this report correspond with those used to calculate the transmission acreage impacts used in the December 2012 and were based on the U.S. Forest Service National Hierarchical Framework adopted by the Forest Service Ecological Classification and Mapping Task Team. The ecoregions are shown below on the left and their equivalent nomenclature from the December 2012 report are shown on the right:

Ecoregion	**December TTG Nomenclature**
Cadiz Valley and Chocolate Mountains	East Riverside
Imperial Borrego Valley	Imperial; Chocolate Mountain
Kingston and Funeral Mountains - Total	Death Valley
Mojave and Silurian Valley - Total	Barstow; portions of Ivanpah
Owens River Valley	Owens Valley
Panamint Death Valley - Total	Alt 5 Ridgecrest; Alt 6 Barstow 1
Pinto Lucerne Valley and Eastern Slopes	Lugo-Victorville-Jasper
Piute Valley and Sacramento Mountains	None
Providence and Buillion Mountains	Needles
West Mojave and Eastern Slopes	Antelope-Vincent; Tehachapi; Ridgecrest

Table 3-1. Alternative 1 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG[18]	Total
Cadiz Valley and Chocolate Mtns	2,775	73	-	271	3,120
Imperial Borrego Valley	5,134	8	2,791	781	8,713
Kingston and Funeral Mountains	-	-	-	-	-
Mojave and Silurian Valley	592	-	9	133	733
Owens River Valley	820	-	-	-	820
Panamint Death Valley	-	-	-	-	-
Pinto Lucerne Vy & Eastern Slopes	1,453	133	-	220	1,806

[17] For purposes of the DRECP, ecoregions were incorporated to divide the large plan area into geographic units. The U.S. Forest Service defined ecological sections and subregions (i.e., ecoregions) within California as part of the U.S. Forest Service National Hierarchical Framework adopted by the Forest Service Ecological Classification and Mapping Task Team.

[18] Distributed Generation (DG) is a classification of generation defined by the limited size of the projects and the likely distribution of projects. For the purpose of analysis, DG was considered to be projects of 20MW, occupying 142 acres sited on disturbed and agricultural land. The acreage requirement for DG systems was 7.1 acres per MW.

Piute Valley and Sacramento Mtns	-	-	-	-	-
Providence and Bullion Mountains	234	-	-	44	278
West Mojave and Eastern Slopes	3,701	183	1	968	4,853
Grand Total	14,708	398	2,800	2,417	20,323[19]

Table 3-2. Alternative 2 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Cadiz Valley and Chocolate Mtns	1,932	1,486	-	271	3,689
Imperial Borrego Valley	2,869	1,189	2,586	781	7,426
Kingston and Funeral Mountains	193	109	-	-	302
Mojave and Silurian Valley	361	274	6	40	681
Owens River Valley	125	96	207	-	428
Panamint Death Valley	102	28	-	-	130
Pinto Lucerne Vy & Eastern Slopes	716	1,340	-	297	2,353
Piute Valley and Sacramento Mtns	-	-	-	-	-
Providence and Bullion Mountains	189	294	-	16	498
West Mojave and Eastern Slopes	2,810	994	0	1,012	4,817
Grand Total	9,296	5,810	2,800	2,417	20,323[20]

Table 3-3. Alternative 3 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Cadiz Valley and Chocolate Mtns	2,660	237	-	271	3,168
Imperial Borrego Valley	4,658	69	2,576	781	8,083
Kingston and Funeral Mountains	-	-	-	-	-
Mojave and Silurian Valley	468	-	6	84	558
Owens River Valley	300	-	218	-	517
Panamint Death Valley	265	-	-	-	265
Pinto Lucerne Vy & Eastern Slopes	1,340	427	-	262	2,028
Piute Valley and Sacramento Mtns	-	-	-	-	-
Providence and Bullion Mountains	268	-	-	45	313
West Mojave and Eastern Slopes	3,933	481	0	974	5,389
Grand Total	13,894	1,212	2,800	2,417	20,323[21]

Table 3-4. Alternative 4 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Cadiz Valley and Chocolate Mtns	4,870	1,091	-	542	6,503
Imperial Borrego Valley	2,597	16	2,546	781	5,940
Kingston and Funeral Mountains	91	-	-	-	91
Mojave and Silurian Valley	324	-	7	84	415

[19] The MW total was rounded from 20,323 to 20,000 in recognition of the general programmatic nature of the planning effort.

[20] Ibid.

[21] Ibid.

Table 3-4. Alternative 4 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Owens River Valley	239	-	247	-	486
Panamint Death Valley	118	-	-	-	118
Pinto Lucerne Vy & Eastern Slopes	737	360	-	70	1,166
Piute Valley and Sacramento Mtns	-	-	-	-	-
Providence and Bullion Mountains	124	-	-	28	152
West Mojave and Eastern Slopes	3,804	736	1	913	5,453
Grand Total	12,904	2,202	2,800	2,417	20,323[22]

Table 3-5. Alternative 5 MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Cadiz Valley and Chocolate Mtns	3,306	1,356	-	271	4,934
Imperial Borrego Valley	3,673	110	2,592	781	7,156
Kingston and Funeral Mountains	419	-	-	-	419
Mojave and Silurian Valley	364	-	-	46	410
Owens River Valley	91	-	208	-	299
Panamint Death Valley	-	-	-	-	-
Pinto Lucerne Vy & Eastern Slopes	888	714	-	66	1,669
Piute Valley and Sacramento Mtns	-	-	-	-	-
Providence and Bullion Mountains	141	-	-	25	166
West Mojave and Eastern Slopes	3,154	889	-	1,227	5,270
Grand Total	12,036	3,070	2,800	2,417	20,323[23]

Table 3-6. No Action/No Project Alternative MW Distribution

Ecoregion	Solar	Wind	Geothermal	DG	Total
Cadiz Valley and Chocolate Mountains	5,071	-	-	267	5,337
Imperial Borrego Valley	5,337	925	316	247	6,824
Kingston and Funeral Mountains	-	-	-	-	-
Mojave and Silurian Valley	555	-	-		556
Owens River Valley	-	-	-	-	-
Panamint Death Valley	-	-	-	-	-
Pinto Lucerne Valley and Eastern Slopes	137	128	-	7	272
Piute Valley and Sacramento Mountains	-	-	-	-	-
Providence and Bullion Mountains	401	-	-	85	486
West Mojave and Eastern Slopes	2,336	4,389	-	123	6,846
Grand Total	13,837	5,442	316	728	20,323[24]

In addition to the approximately 20,000 MW presented in Tables 3-1 through 3-6, the TTG accounted for the additional 1,500 MW of potential renewable energy development on DOD lands, that is not included

[22] Ibid.

[23] Ibid.

[24] Ibid.

from DRECP planning but would require transmission to load centers (see Section 4.4 for details on assumptions for DOD Lands).

3.2 Standardized Grid Components and Expected Acreage Impacts

Standard transmission grid components were assembled to derive a conceptual transmission plan for each alternative. For substations, the acres of permanent land conversion are based on the transmission voltages that the substations were designed to serve. Transmission line length and width are based on the approximate distance (length) to substation locations and the right-of-way (ROW) (width) requirements. Access road length and width are based on the size of the substation, the length of the transmission line, and standard construction methods. Each 230 kV and 500 kV line is assumed to require a permanent access road. The use of helicopters to install transmission lines may reduce the need for access roads in certain situations, but such a site-specific analysis was beyond the scope of the TTG effort. Table 3-7 provides typical characteristics of standard bulk transmission components.

Table 3-7. Typical ROW Widths and Per Mile Impacts of Bulk Transmission

Transmission Line Voltage	ROW Corridor Width (ft.)	ROW Access Road Width (ft.)	Impact Acreage for 1 Mile (Acres)
34.5 and 66 kV			
Double Circuit Tower Line	30	N/A	3.6
230 kV			
Double Circuit Tower Line	100	24	15
500 kV			
Single Circuit Tower Line	200	24	27
Two Single Circuit Tower Line	450	24	57
Three Single Circuit Tower Line	700	24	88
Four Single Circuit Tower Line	950	24	118

Notes:

- ROW spacing is based on Western Electricity Coordinating Council (WECC) Adjacent Circuits definition in order to avoid credible N-2 contingency considerations for lines operated above 300 kV[25].
- Access road width is added to ROW width for total width of linear disturbance.

Transmission and Substation Terminology

The basic assumptions used to define impacts of transmission components are the following:

Collector Lines

Collector lines are the transmission lines that carry electricity from generation projects to the first substation off the project site. These lines are also called generation intertie, or gen-tie lines.

- **34.5 and 66 kV Collector Lines** – 34.5 and 66 kV collector lines connect generation projects less than or equal to 100 MW to substations. 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

[25] http://www.wecc.biz/library/Documentation%20Categorization%20Files/Regional%20Criteria/TPL-001-WECC-CRT-2%20System%20Performance%20Criterion%20-%20Effective%20April%201%202012.pdf and http://www.wecc.biz/library/WECC%20Documents/Publications/WECC%20Glossary%2012-9-2011.pdf

acreage of 36 acres. The 30 foot ROW accommodates both single circuit and double circle lines and assures maximum utilization of facilities within the ROW.

- **230 kV Collector Lines** –230 kV collector lines are required for projects greater than 100 MW and have varying lengths. Single circuit and double circuit lines are assumed to occupy the same ROW width of 124 feet, which includes a 24 foot width for access roads.

Collector Substations

Collector substations receive transmission lines from generation projects or from smaller collector substations.

- **66 kV Collector Substation** – A 66 kV collector substation serves as the receiving point for 66 kV collector transmission lines. These substations are assumed to require 39 acres of land.
- **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 are assumed to require 77 acres of land.
- **500/230 kV Collector Substation** – A 500/230 kV substation serves as the receiving point for 500 kV and 230 kV collector lines and 230/66 kV collector substations. These substations are assumed to require 176 acres of land.
- **500/230/66 kV Super Collector Substation** – This is the largest and 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 bulk electric grid. These substations are assumed to require 215 acres of land.[26]

Connector Lines

Connector lines connect smaller substations to larger substations, and they connect large substations to each other.

- **230 kV Connector Lines** – The 230 kV connector lines connect the 230/66 kV collector substations with the 500/230 kV collector substations and also connect with other logical points on the existing high voltage transmission grid. They are of variable length. Single circuit and double circuit lines are assumed to occupy the same ROW width of 124 feet, which includes a 24 foot width for access roads.
- **500 kV Connector Lines** – 500 kV connector lines connect the 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. Each additional single circuit 500 kV line situated immediately adjacent to another would occupy 250 feet centerline to centerline (including 24 feet for road access) using Western Electricity Coordinating Council (WECC) spacing.[27] A 500 kV collector line can be of variable length so the acreage is calculated individually for each line.

Delivery Lines

Delivery lines are the 500 or 230 kV transmission lines that support the bulk power transfer of electricity by delivering it from generation centers to load centers (generally outside of the DRECP). Individual single circuit 500 kV lines have a ROW (width) requirement of 200 feet with an additional 24 feet for

[26] All 500 kV lines are assumed to be single circuit.

[27] Use of WECC spacing ensures that impacts to one line do not affect the operation of adjacent lines.

road access. Each additional single circuit 500 kV line next to another would occupy 250 feet, 200 feet for the ROW with 50 feet between each 500 kV ROW for a total of 450 feet of assumed disturbance for 2 500 kV lines. A 500 kV delivery line can be of variable length so the acreage is calculated individually for each line. The 500 kV lines are generally alternating current (AC) lines, but a single direct current (DC) delivery line is described in the plan to accommodate power transfer to the Los Angeles Basin. For the purposes of this analysis, the DC line is treated the same as a single 500 kV AC line in terms of acreage and mileage for impact assessment. The characteristics of 230 kV lines are described under "230 kV Connector Lines" (above).

3.3 Identifying Distribution and Amount of Generation for Each Alternative

The amount and location of generation is different for each alternative and is described in Section 3.1. The DRECP team provided the TTG with the technology type and proposed generation amount for each DFA and alternative. Information on the size and mix of technologies and how they are distributed in the DFAs enables the calculation of 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. Solar and wind provide varying amounts of energy at different times of the day with some expected overlap while geothermal energy is essentially assumed to be constant output consistent throughout any 24 hour period unless restricted. To account for this, delivery lines were sized to accommodate the expected simultaneous output of the different renewable technologies within each DFA for the time period (month and hour) used to conduct the transmission analysis.

To define the potential transmission, the distribution of generation was defined for each DFA by the DRECP consultants. The TTG used a statistically-determined expected percentage of output from each technology within each DFA to estimate the maximum simultaneous output of all renewable generation within the DFA.[28] In contrast, collector lines that connect the generators within each DFA to the collector substations were sized to accommodate the maximum possible combined output of all generators within the DFA. The TTG also grouped DFAs into "transmission subareas" where proximate DFAs would be served by a single new transmission line; these subareas are identified above as the December TTG Nomenclature, See Section 3.1.

3.4 Assumptions about Electricity Displacement

Generation of renewable power in the California desert will reduce the amount of electricity generated elsewhere. This report retains the assumptions presented in Section 3.4 of the December 2012 report,. Among others, these assumptions included that the availability of existing transmission is based on the 2020 pre-renewable cases prepared by the CTPG and that in the years leading up to 2040 transmission additions 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 availability of existing transmission capacity in 2040.

The renewable energy estimated to be generated from within the DFAs was assumed to displace less efficient thermal generation which has higher variable operating costs throughout the WECC region in the following distributions:

- 25% of displaced thermal generation would be from gas-fired generators in Southern California;

[28] To calculate the maximum simultaneous output of all renewable generation within a DFA, the TTG assigned 88% output to DG, 90% output for geothermal, 80% output for solar, and between 28 and 53% output for wind depending on the DFA and its geographic location within the DRECP map.

- 25% of displaced thermal generation would be from gas-fired generators in Northern California;
- 25% of displaced thermal generation would be from gas-fired generators in the Pacific Northwest (PNW); and
- 25% of the displaced thermal generation would be from gas-fired generators in the states of the desert Southwest (SW), including Arizona, Nevada, and New Mexico.

A power flow simulation program would normally be used to determine the resulting grid power flows. However, given limited time and resources available for TTG analysis, no power flow simulations were conducted for this exercise by the TTG. Instead, the TTG used spreadsheet analysis to roughly estimate the resultant grid power flows. The spreadsheets identified the general locations where new delivery lines may be needed to accommodate grid impacts that result from the addition of new renewable generation in the DFAs and the associated reduction in fossil-fired generation throughout the WECC.

4. Conceptual Transmission Plan – Data and Results

This section presents the potential transmission system additions and improvements for each DRECP alternative, identifying the linear miles and affected acreage of gen-ties, connector transmission, and substations. The linear miles and acreages of the delivery lines are shown separately. The delivery lines are defined as the bulk transmission additions to California's high-voltage transmission grid system that would accommodate the output of renewable generation within the DFAs and the associated reduction in fossil-fired generation throughout the WECC.

4.1 First Round Transmission Scenarios: RESA Analysis (February - June 2012)

The TTG was created by the REAT agencies in January 2012 to develop the conceptual transmission additions that could be required by renewable energy development in the DRECP. The overall task as defined in the "DRECP Transmission Technical Group - Draft Work Plan for Developing DRECP Transmission Scenario" was to develop transmission scenario/descriptions in response to high and low renewable generation scenarios in RESAs.

After developing an initial approach to the analysis, members of the TTG participated in multiple public meetings including a presentation of the "tinker toy" methodology, the basis for all the TTG reports.[29] The "tinker toy" methodology was to identify a series of standardized transmission grid components that were mixed and matched to provide new transmission capacity sufficient to meet the net, unplanned future transmission capacity requirements. The TTG provided the transmission plan for the RESAs in April 2012 including acreage calculations and the initial report[30] with a corrected version was posted in June 2012, completing the first round of TTG work.[31]

4.2 Second Round Transmission Methodology for DFA Analysis (December 2012)

The methodology for the second round of plan development sequence was:

- Assess the amount of MW from the DFA scenarios that can be interconnected and accommodated utilizing the approved transmission projects (with Certificate of Public Convenience and Necessity or equivalent environmental permits) under construction and planned to be in service in the 2010–2020 timeframe. Subtract this planned available transmission capacity amount from the simultaneous output of renewable generation assumed to be located within each DFA for the low and high renewable scenarios. This results in the net, unplanned future transmission capacity requirements.
- Identify a series of standardized transmission grid components that can be mixed and matched to provide new transmission capacity sufficient to meet the net, unplanned future transmission capacity requirements.

[29] Presentations by IID, LADWP, PG&E, and SCE are available at: http://www.drecp.org/meetings/2012-02-09-10_meeting/presentations/. Background materials for this meeting including the TTG Guidance document are available at: http://www.drecp.org/meetings/2012-02-09-10_meeting/background_materials/.

[30] Presentations and calculations are available at: http://www.drecp.org/meetings/2012-04-25-26_meeting/presentations/ and http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/

[31] Transmission Impacts in the DRECP while paper is available at: http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/Transmission_Technical_Group_report_final_4_16_12.pdf

- o A set of standardized transmission and substation components was 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;
- o A MW transfer capability to accommodate DFA renewable generation was defined for each standardized transmission component; and
- o A land footprint was defined for each standardized transmission component that would facilitate the calculation of total acreage that would be implicated by the construction, operation, and maintenance of each standardized component.

- Define collector (gen-tie) lines derived from the likeliest locations for generation development within the identified DFAs; potential locations were derived from currently known proposed projects.
- Identify potential locations for hub collector substations based upon the likeliest locations for generation development within each DFA.
- Develop interconnection locations to the existing bulk transmission grid based on currently known grid configuration, load growth patterns, and reliability compliance needs.
- Identify the geographic areas where new transmission would be located to mitigate the power flow impacts associated with the displacement of higher variable cost thermal generation throughout the WECC region by the renewable generation from the DFAs.
- Specify the size and number of bulk power "delivery lines" within the geographical areas that mitigate the power flow impacts associated with the displacement of higher variable cost thermal generation by the renewable generation from the DFAs. These impacts would occur on the bulk transmission system in southern California and on the transmission system connecting Southern and Northern California. The displacement of higher variable cost thermal generation is described in Section 3.4.
- Assess and identify the likely land acreage of the collector lines connecting DFA generation resources to collector substations, the new collector substations, and new bulk power delivery lines. These land acreages would reflect ROW requirements for new transmission and the typical footprint of new substations.
- Estimate the acreage and miles that would be located outside the DRECP map boundary.

The results of this work were provided in a October 2012 Report that evaluated transmission requirements for DFAs.[32]

4.3 Dispersion Methodology for DFA Analysis

The TTG completed extensive planning work for the December 2012 report which provided the utilities with a comprehensive overview of the general transmission planning requirements to transport approximately 14,000 MW from the DRECP development areas to the load areas including the 1,500 MW assumed on DOD lands. In response to the revised 2013 alternatives, the TTG reviewed the updated DFAs and MW distribution and recognized that the revisions were similar in nature to the DFAs and MW as presented in the December 2012 report. The TTG updated the transmission system acreages in the following manner:

- Reviewed overall and specific DFA level renewable generation changes in the revised 2013 alternatives and compared these values to those of the old alternatives from the December 2012

[32] http://drecp.org/meetings/2012-09-05_ttg_meeting/2012-09-05_ttg_presentation.pdf

report, see Section 2.4 for a description of the revisions to the alternatives and Table 4-1 for MW distribution for each Ecoregions under each alternative.

- Reviewed December 2012 DFA locations and compared them with the revised 2013 alternatives' DFA locations.
- Recommended use of a dispersion approach to update the transmission system expansion after considering the revisions between December 2012 DFA locations and associated MW and revised 2013 DFA locations and associated MW distribution.

Key observations based on the comparison of the revised 2013 alternatives with the December 2012 alternatives by the TTG were that:

- The majority of the renewable MW range of the alternatives had not changed appreciably compared with the December 2012 report, see Figure 4-1.
- The acreages impacted by renewable generation value ranges had also not changed significantly compared with the December 2012 report, see Figure 4-1.
- For geothermal and DG there had been no change in generation from the December 2012 report, see Figure 4-1.

As can be seen from Figure 4-1, the first four columns (columns 2 through 5) under the header "Range of Renewable MW" show the range in MW (minimum to maximum value) for solar and wind generation resources for the December 2012 alternatives (under column 2) and for the Revised 2013 alternatives (under column 4). Also shown under column 3 and column 5 are the calculated delta values which represent the difference in the spread (maximum minus minimum values of the range) for the solar and wind generation for December 2012 alternatives and the revised 2013 alternatives. The calculated delta values are 5,686 MW for both solar and wind resources for December 2012 alternatives whereas these delta values are 5,412 MW for both solar and wind resources for the revised 2013 alternatives. The delta numbers are identical within the December 2012 and 2013 alternatives for solar and wind resources and fairly close in comparison to each other (5,686 under old alternatives vs. 5,412 under the revised alternatives). Additionally, the Geothermal and the DG renewable generation are constant at 2,800 MW and 2,417 MW respectively under the old and revised alternatives. As such, it can be concluded that the changing amounts of solar and wind resources under the old and revised alternatives represent a small scale of change. These changes indicate a methodology based on the set of acreage results would be appropriate.

Similarly, when looking at the range of generation acres and its calculated delta values in Figure 4-1, the numbers remain very similar in magnitude under the old and the revised alternatives. This further substantiates that the acreages for the solar and wind generation have changed by small amounts under both the December 2012 and the revised 2013 alternatives as a result of the relatively small increase expected in solar development and similarly small decrease in wind development.

After considering this information, the TTG concluded that a dispersion factor derived from the transmission acres per MW of renewable energy was a reasonable approach to approximate the affected acreage due to transmission requirements for the current alternatives. This dispersion factor was multiplied by the total renewable 14,000 MW required for each alternative (20,000 plus the 1,500 MW assumed for DOD lands minus the 7,500 MW on transmission lines already approved or under construction) from the December 2012 report to provide updated transmission system impact acreages.

Having calculated the initial updated transmission impact acreage, the TTG adjusted the dispersion methodology to account for additional increase or decrease in the associated length of the transmission within each specific DFA based on the related increase or decrease of renewable generation within that DFA and any shift of generation from one DFA to other DFAs and also between the revised DFAs and the load centers of each new alternative. The TTG determined a transmission length change and related land impact acreage factor (Transmission acreage/MW) due to renewable relocation among DFAs that was derived from the December 2012 transmission acreages divided by the December 2012 MW distribution. This factor was multiplied by the difference between the current MW distribution and the December MW distribution for each DFA. The total adjusted acreages was the sum of the adjusted acreages using the dispersion approach and the acreage adjustment due to resulting different transmission length changes within DFAs.

The key steps the TTG utilized to ensure the validity of the process and accuracy in results were:

1. Compared the overall renewable generation between the two sets of alternatives, (December 2012 and the revised October 2013 alternatives) and confirmed the total renewable generation as 20,323 MW (excluding the 1,500 MW renewables on DOD lands) for both sets of alternatives (see Table 4-1).

2. Reviewed the renewable technology distribution associated with each alternative and identify a dominant renewable technology for each December 2012 alternative (see Figure 4-2). The alternatives were categorized either (i) 'Solar' dominant Category (Total Solar resources being in the range of 65% to 69% of the Alternative's total renewable generation resources[33]) or (ii) 'Balanced' category with Solar and Wind resources being in the range of 33% to 41% level each of the given Alternative's total renewable generation resources. No similar assessment of Geothermal and DG resources was done as they both are at the same MW level in all alternatives.[34] The TTG then assigned one of the two categories to each October 2013 alternative based on the amount of solar and wind generation and their ranges as described in 2(i) and 2(ii). All revised 2013 alternatives were in the "Solar" dominant category except revised 2013 Alternative 2 which was in the "Balanced solar and wind" category.

3. Calculated the land impact conversion factor (Transmission Land Impact in Acres divided by total renewable generation MW[35]) for each December 2012 alternative (see Figure 4-2).

4. Evaluated the dominant renewable technology category for all 2013 alternatives based on Step 2 categories and assigned to them the land impact conversion factor (Step 3 above) calculated for each old alternative based on a comparison of similar levels of solar and wind generation percentages and assigned categories of the old and revised alternatives (see Figure 4-2).

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[33] Similarly across all of the revised 2013 alternatives the assessment established the percentage share of solar technology in case of solar dominant category ranged from 59% to 72% alternatives with midpoint being 65%. Similarly across all of the revised 2013 alternatives the assessment also established the percentage share of solar and wind technology in the 'Balanced Category' ranged from 28% to 46%. The midpoint is 37%.

[34] Similarly, the assessment established that across all old 2012 alternatives and the revised 2013 alternatives, the percentage share of geothermal and DG technologies remained constant at 14% and 12% respectively

[35] The total renewable generation 20,000 MW were adjusted to include the MW that would be developed on DOD lands (+1,500) and exclude the transfer capability of known collector facilities and approved delivery line projects that are currently under construction or recently operational (-7,500).

Table 4-1. MW Distribution by Ecoregion for each DRECP Alternative

Ecoregion	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		No Action Alternative	
	Current MW	December 2012 MW	Current MW	December 2012 MW (Alt 5)	Current MW	December 2012 MW (Alt 1)	Current MW	December 2012 MW (Alt 6)	Current MW	December 2012 MW (Alt 2)	Current MW	December 2012 MW
Cadiz Valley and Chocolate Mountains	3,120	2,126	3,689	2,717	3,168	2,126	6,503	2,277	4,934	2,081	5,337	N/A
Imperial Borrego Valley	8,713	9,730	7,426	7,635	8,083	9,730	5,940	8,463	7,156	7,643	6,824	N/A
Kingston and Funeral Mountains	-	-	302	93	-	-	91	-	419	199	-	N/A
Mojave and Silurian Valley	733	1,160	681	1,077	558	1,160	415	900	410	983	556	N/A
Owens River Valley	820	216	428	195	517	216	486	191	299	173	-	N/A
Panamint Death Valley	-	-	130	219	265		118	301	-	51	-	N/A
Pinto Lucerne Valley and Eastern Slopes	1,806	1,597	2,353	1,613	2,028	1,597	1,166	1,707	1,669	1,773	272	N/A
Piute Valley and Sacramento Mountains	-	-	-	-	-	-	-	-	-	-	-	N/A
Providence and Bullion Mountains	278	-	498	210	313	-	152	-	166	-	486	N/A
West Mojave and Eastern Slopes	4,853	5,494	4,817	6,564	5,389	5,494	5,453	6,484	5,270	7,369	6,846	N/A
Total	20,323	20.323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	20,323	

Figure 4-1. Comparative Assessment of MW and Associated Generation Acreage Ranges under December 2012 and Revised 2013 DRECP Alternatives by Renewable Technologies

Type of Renewable Technology	Range of Renewable MW				Range of Generation Acres			
	Dec. 2012 Alts.	Calculated Delta	New Alternatives	Calculated Delta	Dec. 2012 Alts.	Calculated Delta	New Alternatives	Calculated Delta
Solar	8,449 - 14,135	5,686	9,296 - 14,708	5412	59,988 - 100,359	40,371	66,002 - 104,430	38,428
Wind	971 - 6,657	5,686	398- 5,810	5412	38,840 - 266,280	227,440	15,901- 232,400	216,499
Geothermal	2,800	0	2,800	0	14,000	0	14,000	0
DG	2,417	0	2,417	0	17,161	0	17,161	0

Key Observations:

1. Calculated Delta between December 2012 and Revised 2013 Alternatives MW data ranges have not changed by any appreciable amounts and are similar in values by renewable technology types under both sets of December 2012 and revised 2013 Alternatives.

2. Similarly, the calculated Delta between December 2012 and Revised 2013 Alternatives' Generation impacted acreages values ranges have not changed by any appreciable amounts and are similar in values by renewable technology types compared to the December 2012 Alternatives and revised 2013 Alternatives.

3. Geothermal and DG MW and associated Impacted Generation Acreages remain the same under the December 2012 and the Revised 2013 Alternatives

Figure 4-2. Results derived for the Revised 2013 Alternatives based on the December 2012 Alternatives

(A) Percentage Share of Generation MW of all Renewable Technologies for the December 2012 and Revised 2013 Alternatives

Type of Renewable Technology	Alternative - 1		Alternative - 2		Alternative - 3		Alternative - 4		Alternative - 5		Alternative - 6	
	Dec. '12	Revised 2013	Dec. '12	Revised 2013 (Similar to Dec. '12 Alt. 3 & 5)	Dec. '12	Revised 2013 (Similar to Dec. '12 Alt. 4 MW not done)	Dec. '12	Revised 2013 (Similar to Dec. '12 Alt. 6 MW)	Dec. '12	Revised 2013 (Similar to Dec. '12 Alt. 2 MW)	Dec. '12	Revised 2013 (No Action Alt.)
Solar	69%	72%	41%	46%	69%	68%	not done	63%	64%	59%	65%	67%
Wind	5%	2%	33%	28%	5%	6%	not done	11%	10%	15%	9%	27%
Geothermal	14%	14%	14%	14%	14%	14%	not done	14%	14%	14%	14%	2%
DG	12%	12%	12%	12%	12%	12%	not done	12%	12%	12%	12%	4%

(B) Assessment of Dominant Renewable Generation Pattern based on above renewable generation percentages and Calculation of Conversion Key Factor (Acres / MW) using Dec. 2012 Alternatives developed transmission acreages and renewable MW following the 7 Steps below)

1.	Dominant Renewable Pattern Results derived (based on above renewable percent % data for Dec. 2012 Alts.)	**Solar**		**Balanced**		**Solar**		**not done**		**Solar**		**Solar**	
2.	Dec. 2012 Alts. Transmission Land Impact (Trans. Acres)	32,844		31,228		32,210		not done		33,965		29,549	
3.	Dec. 2012 Alts. Total Renewable (Including DOD, excluding 7,500) MW	14,323	14,323	14,323	14,323	14,323	14,323	14,323	14,323	14,323	14,323	14,323	14,323
4.	Dec. 2012 Alts. Calculated Conversn. Factr. (Trans. Acres / MW)	***2.29***		***2.18***		***2.25***				***2.37***		***2.06***	
5.	Derived Dominant Generation Pattern for Revised 2013 Alts.		***Solar***		***Balanced***		***Solar***		***Solar***		***Solar***		***Solar***
6.	Selected Conversion Factor for Revised 2013 Alts. based on comparison with Dec. 2012 Alts. Dominant Renewable Technology Pattern (Acres/MW)		2.29		2.18		2.25		2.06		2.37		not done
7.	Calculated Transmission Land Impact for Revised 2013 Alts. (Acres) utilizing the Conversion Factor for the Revised 2013 Alts. in Step - 6 above		32,800		31,224		32,227		29,505		33,946		

5. Calculated the revised transmission land impact in acres for each new 2013 alternative based on its dominant renewable technology type by multiplying its total overall renewable generation MW under the revised alternative by the assigned conversion factor (Step 4 above) based on the total renewable generation, as shown in Figure 4-2 last line.

6. Evaluated the DFA specific generation dispersion impact (including shifting of generation among DFAs) in the following five steps, shown for Alternative 5 only in Figure 4-3 columns from left to right after the first column listing the Ecoregions:

   (i) Assessed each DFA's renewable generation MW (to reflect its increased or decreased generation level and its dispersion to other DFAs) for each of the new and old alternatives;[36]

   (ii) Assessed the December 2012 transmission land impact acreage in acres for each specific DFA under the old alternative;

   (iii) Calculated DFA specific land impact conversion factors (Transmission Land Impact Acres/associated renewable generation MW) utilizing December 2012 transmission results for each old alternative;

   (iv) Calculated the increase or decrease (delta) in renewable generation MW level for each specific DFA under the new and old alternatives to reflect the new level of generation dispersion specific to that DFA;

   (v) Calculated the DFA specific transmission land impact acreage in acres (increase or decrease) by multiplying the delta value in MW from sub-step 6 (iv) above with the DFA Specific land impact conversion factor calculated in sub-step 6(iii) to account for increased or decreased dispersion of renewable generation in DFAs for each 2013 alternative

7. Adjusted the transmission land impact acreage in acres calculated in Step 5 by adding or subtracting the DFA specific land impact acreages in acres for all DFAs in each of the new alternative calculated in sub-step 6(v) to generate the final total Transmission Land Impact Acreage in acres for each of the new alternative.

[36] See Figure 4-2. This figure illustrates how MW shifted from one DFA to another. The increase or decrease in MW for each ecoregion was multiplied by an acreage/MW factor calculated by the TTG using the December 2012 data and the result was used to adjust the overall transmission land impact results to account for the DFA specific differences in renewable generation MW.

Figure 4-3. Example of Renewable Resources Relocation among Ecoregions and Acreage Adjustment Evaluation for DFA Specific Dispersion for Alternative 5

Alternative 5	New MW	Dec MW	Dec Transmission Acreage	Acreage/ MW	New MW-Dec MW	Additional Acreage
Cadiz Valley and Chocolate Mountains	4,934	2,081	1,797	1.21	2853	3462
Imperial Borrego Valley	7,156	7,643	9,687	1.50	(487)	(732)
Kingston and Funeral Mountains	419	199	0	0.00	220	0
Mojave and Silurian Valley	410	983	4,136	2.79	(573)	(1598)
Owens River Valley	299	173	593	3.43	126	432
Panamint Death Valley	0	51	316	6.20	(51)	(316)
Pinto Lucerne Valley and Eastern Slope	1,669	1,773	743	0.42	(104)	(44)
Piute Valley and Sacramento Mountair	0	0	0	0.00	0	0
Providence and Bullion Mountains	166	0	0	0.00	166	0
West Mojave and Eastern Slopes	5,270	7,420	2,605	1.12	(2150)	(2414)
Total	20,323	20,323	20,192		0	(1210)

4.4 Consideration of Department of Defense Lands

As noted in the TTG presentation from September 5, 2012, renewable generation has been assumed on DOD lands in the following ways:[37]

- A total of 500 MW of solar generation would be installed within Fort Irwin National Training Center; all would be collected at the Barstow DFA Collector substation via two separate collector lines;
- 1,000 MW of solar generation would be installed at two locations on the Edwards Air Force Base; it would be collected at Tehachapi and Antelope-Vincent DFAs' collector substations;
- No renewable generation would be assumed at the China Lake Naval Air Weapons Station, at Marine Corps Air Ground Combat Center Twentynine Palms, or other DOD facilities;
- The total renewable generation development on DOD land (1,500 MW) would be in addition to total generation that would have to be served with new transmission in the DRECP.

For the transmission plan, at the request of the DOD, the TTG assumed no transmission would be built on the DOD lands. Instead, the DOD provided an exit point location at the base boundaries and the TTG planned for collector lines to the nearest collector substations.

4.5 Transmission Scenarios Based on DFAs

Although the transmission system impact acreages have been adjusted in this DFA analysis, the overall "tinker toy" approach and the standard acreages of disturbance are the basis for the acreages. The transmission plan acreages for each ecoregion the DFA analysis are presented in Table 4-2 for each alternative.

[37] http://www.drecp.org/meetings/2012-09-05_ttg_meeting/2012-09-05_ttg_presentation.pdf

Table 4-2. Acreage of Impacts per Ecoregion for each DRECP Alternative[38]

Ecoregion	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	No Action Alternative
Cadiz Valley and Chocolate Mountains	7,316	8,490	7,502	18,130	12,911	14,375
Imperial Borrego Valley	16,073	14,449	13,915	6,429	12,253	12,116
Kingston and Funeral Mountains	0	716	0	188	914	0
Mojave and Silurian Valley	1,883	1,429	1,095	455	386	2,431
Owens River Valley	2,165	739	828	917	431	0
Panamint Death Valley	0	42	607	243	0	0
Pinto Lucerne Valley and Eastern Slopes	4,214	6,000	4,803	2,062	3,595	645
Piute Valley and Sacramento Mountains	0	0	0	0	0	0
Providence and Bullion Mountains	637	1,181	718	314	362	1,152
West Mojave and Eastern Slopes	1,467	1,169	2,360	1,206	1,796	4,854
Total Inside DRECP	33,755	34,214	31,828	29,944	32,648	35,574
Total Outside DRECP	32,495	31,656	32,495	31,656	29,095	31,656

Figures 1 through 7, presented at the end of this report, illustrate the approximate locations of the major transmission infrastructure additions within and outside of the Plan Area identified in the conceptual transmission plan. Potential new transmission outside of the Plan Area would be located in the SCE, SDG&E, LADWP, and PG&E service areas; Figure 7 illustrates the delivery lines outside of the Plan Area that would serve the PG&E service area.

As noted above, the purpose of the DRECP TTG analysis was to identify a **conceptual transmission plan** and its associated land impacts. The TTG did not conduct a comprehensive siting evaluation, so the transmission lines shown on Figures 1 through 7 should be considered as conceptual only **and these figures only show new lines**. While the acreage of impacts was adjusted in response to the revised alternatives, the lines would follow the same general corridors as identified in the December 2012 report. As such the figures remain the same as those presented in the December 2012 report for the transmission lines.

Due to the complexity of the information presented in the figures, **no existing lines are shown**, but the conceptual lines follow existing ROWs or designated utility corridors where possible.

Transmission Lines for Each Alternative

The 6 alternatives analyzed in this report are described briefly below. Note that all of these lines are ***in addition to*** existing lines and to those already approved. In some cases, multiple additional lines in a

[38] The acreage of impacts presented in Table 4-1 includes ***only*** the new acreage required to carry the renewable energy from the location of generation to the load centers. It does not include any acreage of impacts for the already-approved new transmission lines that are assumed to be operational in the TTG scenario, and that support 7,500 MW of renewable resource development within the DFAs. These lines include the Sunrise Powerlink, Tehachapi Renewable Transmission Project, Devers-Colorado River Project, and the Barren Ridge Renewable Transmission Project.

single corridor would be required; therefore the number of new lines that would be required is noted for each corridor. Note also that there are new delivery lines that would be required to carry power to the PG&E service area for all alternatives. These lines are defined after the description of the No Action Alternative.

Alternative 1

The majority of the renewable generation assumed for Alternative 1 is in Imperial County, followed by the Tehachapi and Barstow areas. The transmission collector lines are primarily in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are listed below.

- One Colorado River to Valley 500 kV line
- One Devers to Vincent 500 kV line
- One Devers to Rancho Vista 500 kV line
- Two Imperial Valley to Sycamore (San Diego) 500 kV lines
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Three Midway X[39] to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- Two Midway to Tesla/Tracy 500 kV lines[40]
- One Whirlwind to Midway 500 kV line

Alternative 2

The renewable generation assumed for Alternative 2 would be distributed throughout the DRECP Plan Area with the focus continuing to be in Imperial County, the Tehachapi and Riverside East (Cadiz Valley) areas. The transmission collector lines are in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are as follows:

- One Colorado River to Valley 500 kV line
- One Devers to Vincent 500 kV line

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[39] "Midway X" Substation is an IID substation located east of the Salton Sea. It is noted as "Midway X" to distinguish it from PG&E's Midway Substation located west of Bakersfield.

[40] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

- One Devers to Rancho Vista 500 kV line
- One Imperial Valley to Sycamore 500 kV line
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Three Midway X to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- One Mead, Station 6 to Station 7 500kV line
- Two Midway to Tesla/Tracy 500 kV lines[41]
- One Whirlwind to Midway 500 kV line

Alternative 3

As noted above, because the MW distribution was similar to the distribution for Alternative 1, Alternative 1 was used as a proxy for this alternative. As such, the transmission requirements for Alternative 3 are substantially similar to those of Alternative 1. The majority of the renewable generation assumed for Alternative 3 is in Imperial County, followed by the Tehachapi and Barstow areas. The transmission collector lines are primarily in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are listed below.

- One Colorado River to Valley 500 kV line
- One Devers to Vincent 500 kV line
- One Devers to Rancho Vista 500 kV line
- Two Imperial Valley to Sycamore (San Diego) 500 kV lines
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Three Midway X[42] to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- Two Midway to Tesla/Tracy 500 kV lines[43]

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[41] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

[42] "Midway X" Substation is an IID substation located east of the Salton Sea. It is noted as "Midway X" to distinguish it from PG&E's Midway Substation located west of Bakersfield.

- One Whirlwind to Midway 500 kV line

Alternative 4

The renewable generation assumed for Alternative 4 would be distributed throughout the DRECP Plan Area with the focus continuing to be in East Riverside (Cadiz Valley), Tehachapi, and Imperial County. The transmission collector lines are in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are as follows:

- Two Colorado River to Valley 500 kV lines
- One Devers to Vincent 500 kV line
- One Devers to Rancho Vista 500 kV line
- One Imperial Valley to Sycamore 500 kV line
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Two Midway X to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- Two Midway to Tesla/Tracy 500 kV lines[44]
- One Whirlwind to Midway 500 kV line

Alternative 5

The renewable generation assumed for Alternative 5 would be distributed throughout the DRECP Planning Area with a larger amount of energy being developed in Imperial County and the Tehachapi area. The transmission collector lines are in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are as follows:

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[43] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

[44] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

- One Colorado River to Valley 500 kV line
- One Devers to Vincent 500 kV line
- One Devers to Rancho Vista 500 kV line
- One Imperial Valley to Sycamore 500 kV line
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Three Midway X to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- Two Midway to Tesla/Tracy 500 kV lines[45]
- One Whirlwind to Midway 500 kV line

No Action Alternative

As noted above, because the MW distribution for the No Action Alternative was similar to the distribution for Alternative 2, Alternative 2 was used as a proxy for this alternative. As such, the transmission requirements for the No Action Alternative are substantially similar to those of Alternative 2. The renewable generation assumed for the No Action Alternative would be distributed throughout the DRECP Planning Area with the focus continuing to be in Imperial County, the Tehachapi and Riverside East (Cadiz Valley) areas. The transmission collector lines are in the Barstow, Lugo-Victorville-Jasper, Imperial, and East Riverside areas. No existing lines are shown on this map. The line segments listed below are shown in existing corridors, where such corridors exist, and are ***in addition to*** existing lines and those already approved. Existing substations are shown only if new lines would interconnect to them. The new delivery lines and primary connector lines are as follows:

- One Colorado River to Valley 500 kV line
- One Devers to Vincent 500 kV line
- One Devers to Rancho Vista 500 kV line
- One Imperial Valley to Sycamore 500 kV line
- One Vincent to Lighthipe 500 kV line
- One Vincent to Mesa 500 kV line
- Three Midway X to Devers 500 kV lines
- One Midway X to Imperial Valley 500 kV line
- One Mead, Station 6 to Station 7 500kV line

[45] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

- Two Midway to Tesla/Tracy 500 kV lines[46]
- One Whirlwind to Midway 500 kV line

Lines Applicable to all Alternatives

In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The new delivery lines to reach the PG&E service area are listed below. These lines are also listed under each of the alternatives.:

- Two Midway to Tesla/Tracy 500 kV lines
- One Whirlwind to Midway 500 kV line

[46] In addition to the lines identified for each individual alternative, the renewable generation assumed the potential new transmission to reach the PG&E service areas. The new transmission would be applicable to all alternatives because some of the renewable development from each alternative would be used in the PG&E service areas. The two new delivery lines needed to reach the PG&E service area are 1) two Midway to Tesla/Tracy 500 kV lines and 2) one Whirlwind to Midway 500 kV line. These lines are also listed separately after all the alternatives.

5. References

This section provides links to the documents referenced in this report. Documents are listed here chronologically, with the oldest documents presented first.

November 2008 Executive Order S-14-08 is available at

http://gov.ca.gov/news.php?id=11072

December 2011

http://www.drecp.org/meetings/2011-12-05_meeting/presentations/

February 2012 presentations by IID, LADWP, PG&E, and SCE are available at:

http://www.drecp.org/meetings/2012-02-09-10_meeting/presentations/

February 2012 - Background materials for this DRECP Stakeholders Committee meeting, including the TTG Guidance document are available at:

http://www.drecp.org/meetings/2012-02-09-10_meeting/background_materials/

February 2012 presentations by LADWP and SCE on the Draft Transmission Plan are available at:

http://www.drecp.org/meetings/2012-02-17_meeting/presentations/Southern_California_Edison_Draft_Transmission_Plan.pdf

March 2012 TTG Status Report Presentation is available at:

http://www.drecp.org/meetings/2012-03-14_meeting/presentations/04_Transmission_Planning_Update.pdf

April 2012 - Information about the Renewable Energy Development Scenarios (RESAs) is available in the presentations for the April 25 and 26, 2012 DRECP Stakeholder Committee Meeting at:

http://www.drecp.org/meetings/2012-04-25-26_meeting/presentations/

April 2012 TTG Presentations and calculations are available at:

http://www.drecp.org/meetings/2012-04-25-26_meeting/presentations/

and

http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/

April/June 2012 TTG Report is at:

http://www.drecp.org/meetings/2012-04-25-26_meeting/background/Transmission_Planning/Transmission_Technical_Group_report_final_4_16_12.pdf

September 2012 TTG status and methodology presentation by SCE is available at:

http://drecp.org/meetings/2012-09-05_ttg_meeting/2012-09-05_ttg_presentation.pdf

Information from the Western Electricity Coordinating Committee (WECC) on transmission right-of-way spacing and terminology is available at:

http://www.wecc.biz/library/Documentation%20Categorization%20Files/Regional%20Criteria/TPL-001-WECC-CRT-2%20System%20Performance%20Criterion%20-%20Effective%20April%201%202012.pdf

and

http://www.wecc.biz/library/WECC%20Documents/Publications/WECC%20Glossary%2012-9-2011.pdf

Figures 1 through 7

Seven maps follow this page:

Figure 1: Alternative 1 Transmission

Figure 2: Alternative 2 Transmission

Figure 3: Alternative 3 Transmission

Figure 4: Alternative 4 Transmission

Figure 5: Alternative 5 Transmission

Figure 6: No Action Alternative Transmission

Figure 7: Delivery Lines from Plan Area to PG&E Territory

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

NOTE: The DRECP TTG is NOT conducting a siting evaluation. **No existing lines are shown**. Lines approved and under construction (e.g., DCR, TRTP, and Barren Ridge) are considered "existing." New lines are assumed to be adjacent to existing lines, where possible. Existing substations are only shown if connected to the new DRECP transmission infrastructure plan.

Substations

IID, Existing
IID, New
IID, Upgrade
LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

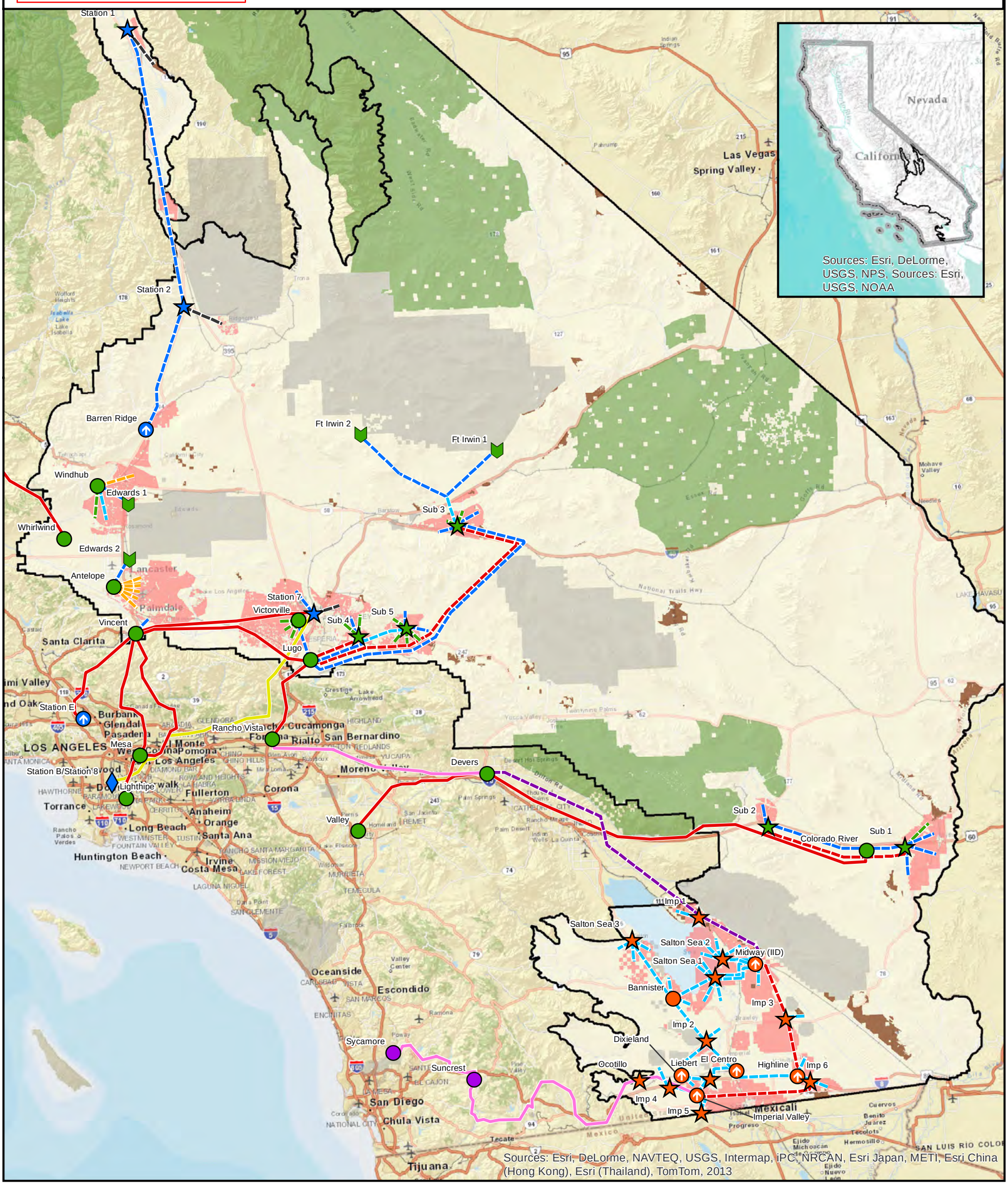
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013 **Alternative 1**

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

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LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

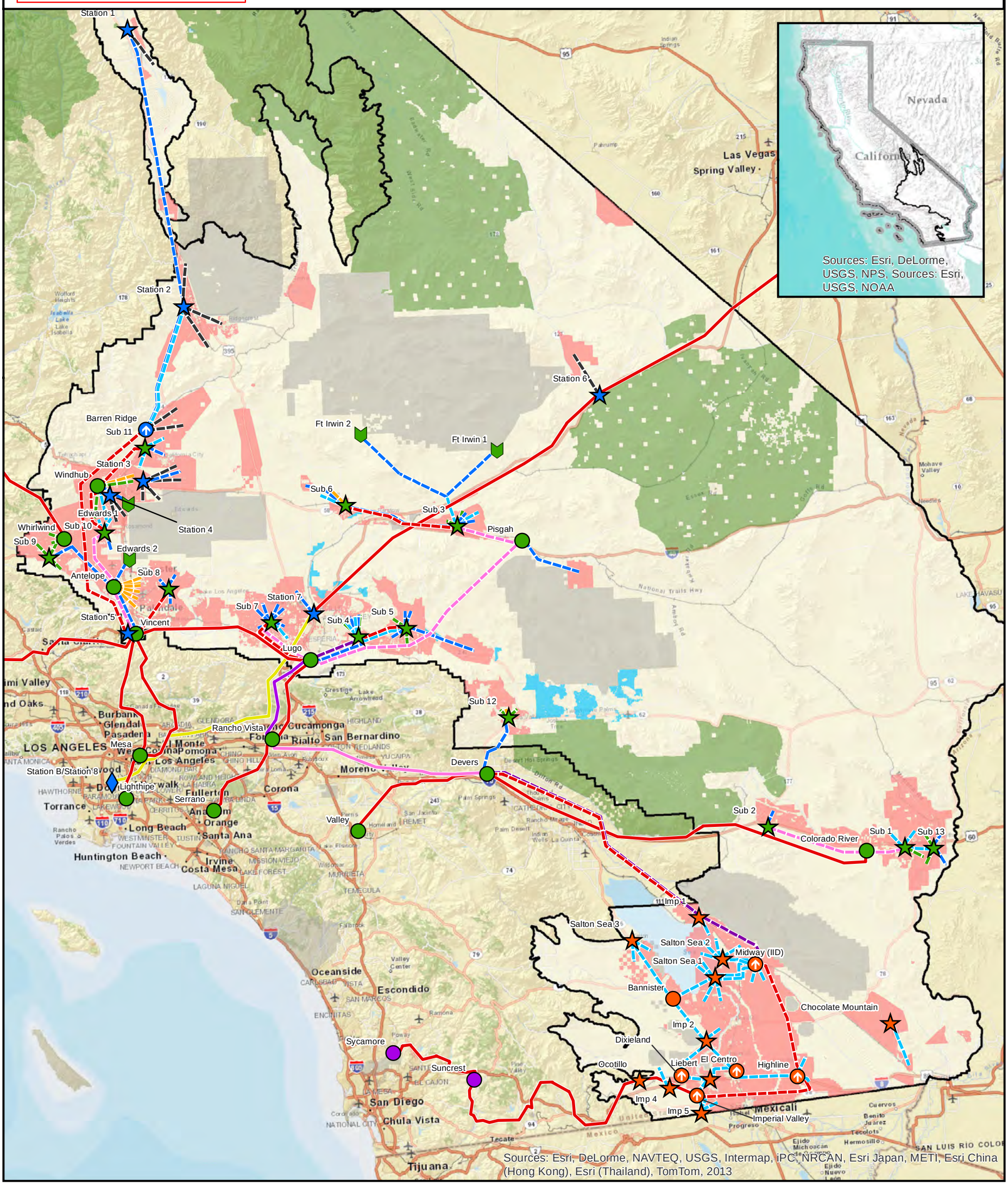
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013 **Alternative 2**

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

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Substations

IID, Existing
IID, New
IID, Upgrade
LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

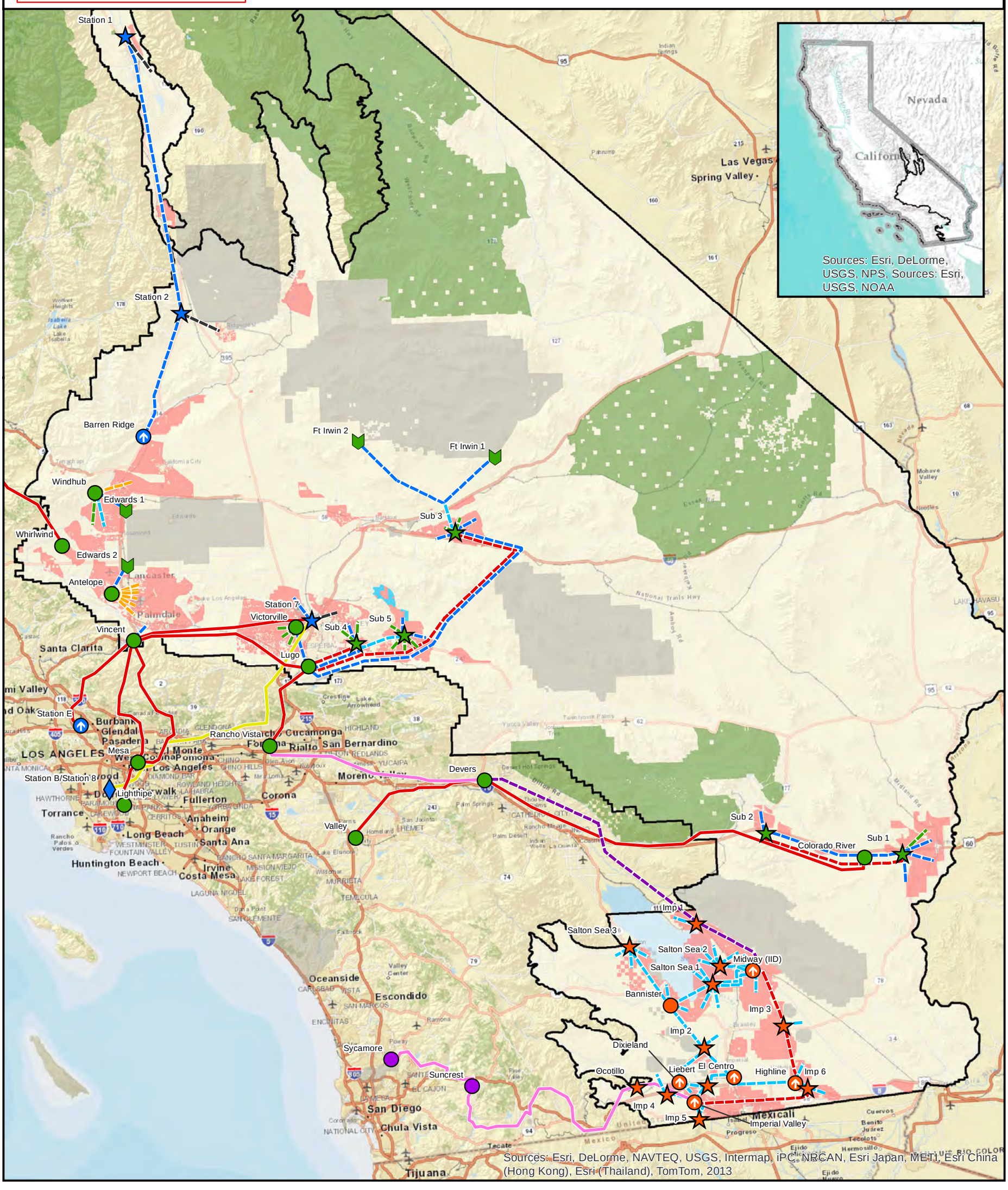
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013

Alternative 3

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

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Substations

IID, Existing
IID, New
IID, Upgrade
LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

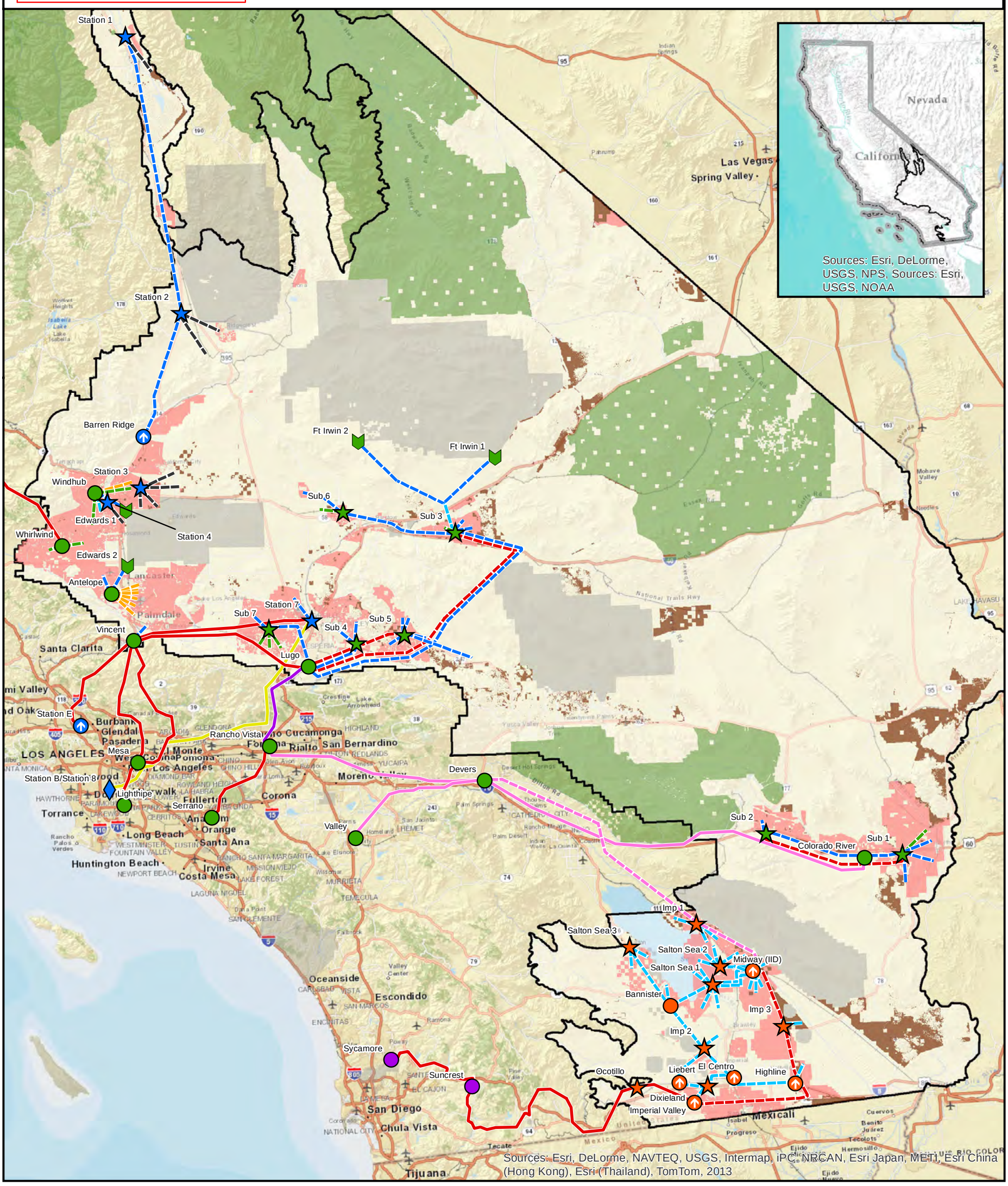
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013 **Alternative 4**

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

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Substations

IID, Existing
IID, New
IID, Upgrade
LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

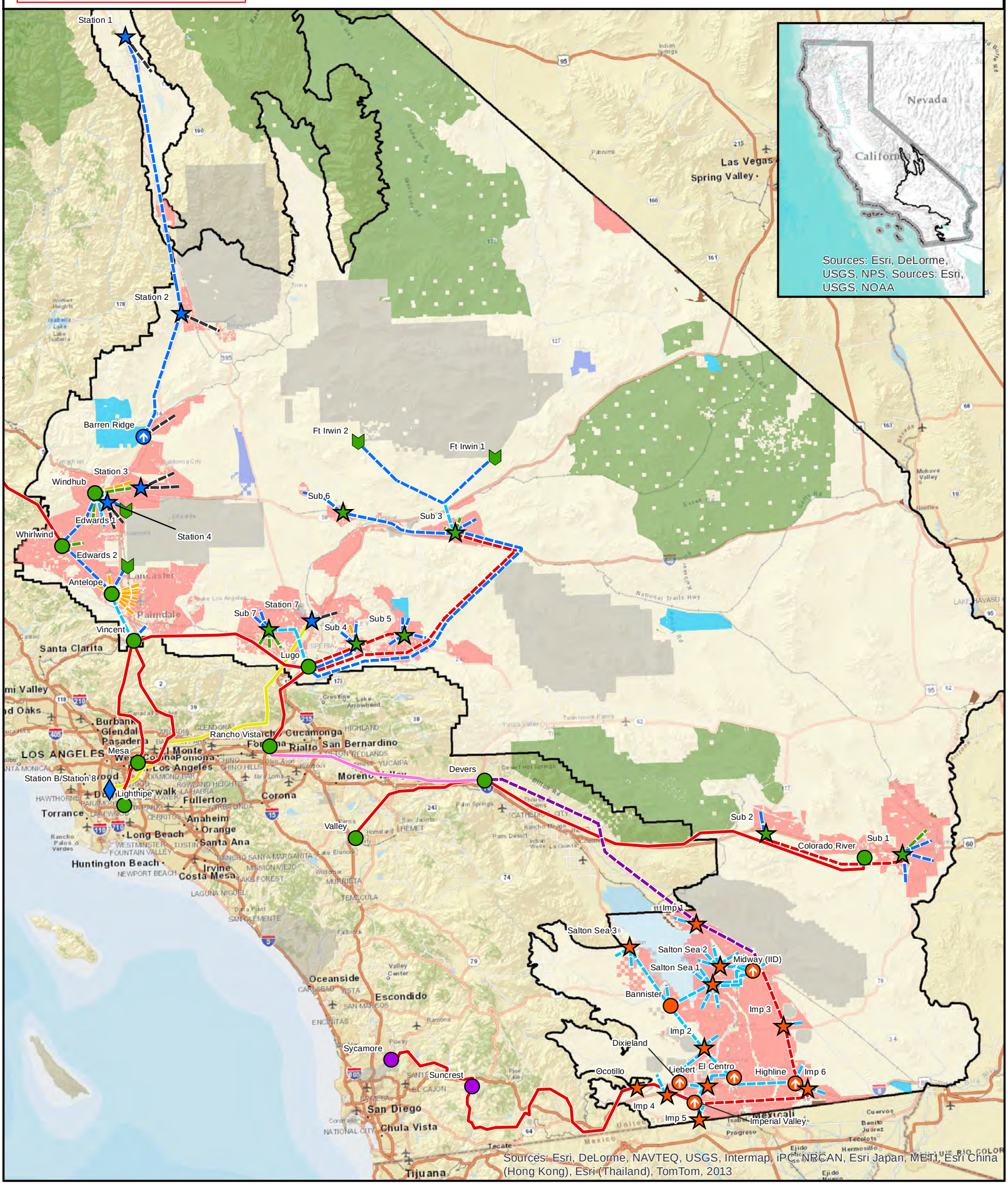
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013

Alternative 5

DRECP Boundary
Development Focus Areas
DRECP Variance Lands
Future Assessment Areas
Special Analysis Areas

Land Ownership

Military
National Park Service

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Substations

IID, Existing
IID, New
IID, Upgrade
LADWP, Existing
LADWP, New
LADWP, New DC Converter
LADWP, Upgrade
PGE, Existing
SCE, Existing
SCE, New
SDGE, Existing

Military Interconnection

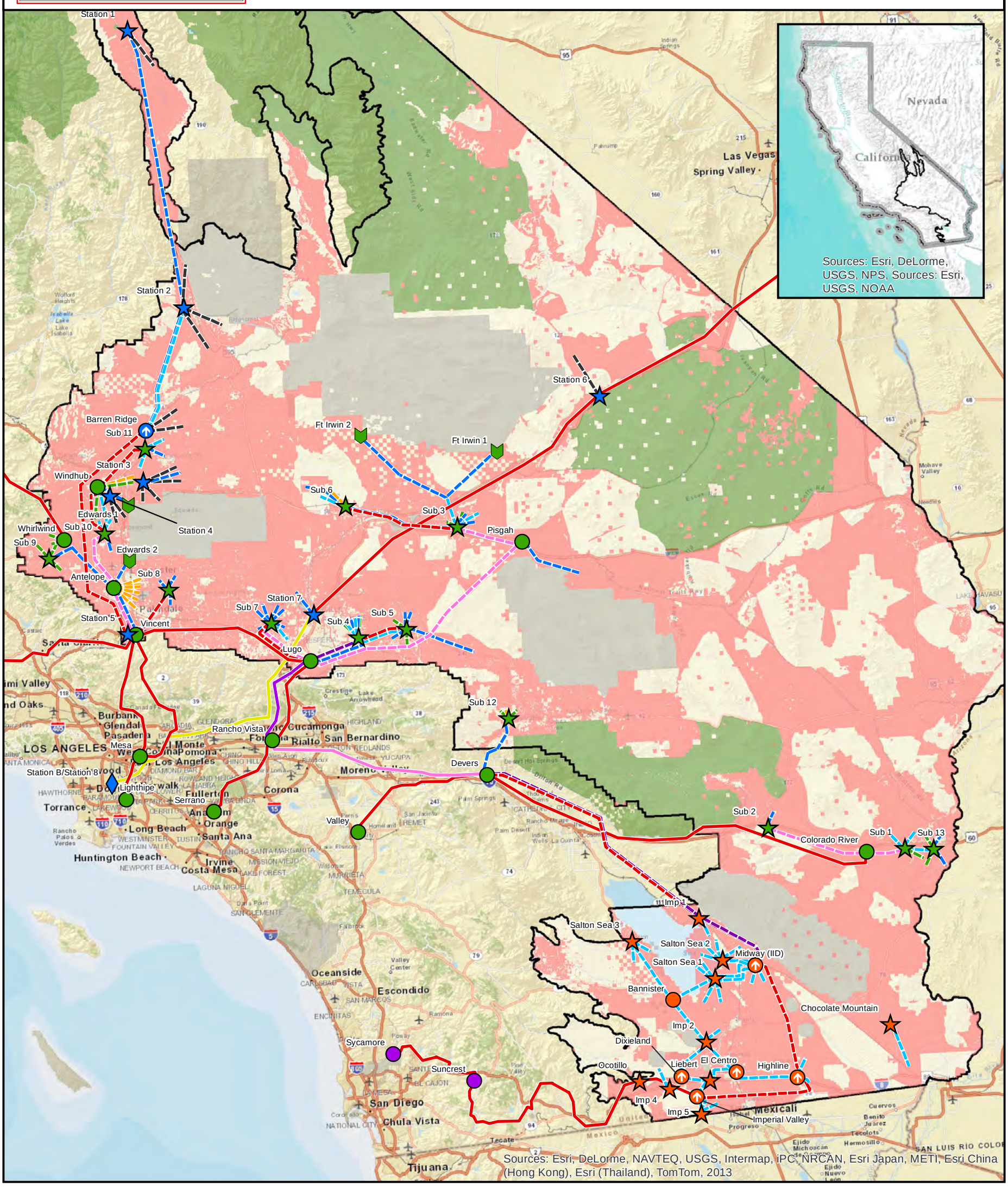
SCE Military Connection

Transmission Lines

500 kV - One Circuit
500 kV - Two Circuits
500 kV - Three Circuits
320 kV DC (Delivery)
220/230 kV - One Circuit
220/230 kV - Two Circuits
66 kV - One Circuit
66 kV - Two Circuits
34.5 kV - One Circuit

Delivery Lines

500 kV Delivery Lines are Solid with Corresponding Colors



September 2013 **No Action Alternative**

September 2013

PG&E Delivery Lines