Section 5: Electric Grid Evaluation



SECTION 5: ELECTRIC GRID EVALUATION

5.1 SECTION PURPOSE

This section presents the assumptions, considerations and limitations that were all factors in the evaluation of the electric grid. Additionally, it contains the planning and technical references necessary to reach the proposed preferred routing in this study. Note that while much of this language is highly technical, it is necessary to capture in order to support future studies and evaluations as the projects proceed.

The evaluations presented in this section were necessary to arrive at a fundamental level of assumptions that would be used to establish the termination points of the transmission line routes. It was critical that the termination points be located such that they support the most physically viable routes (physical element) as well as establish the most viable interconnections to the power market (electrical element). The term "routing" is used throughout this report in discussions pertaining to both electric grid evaluation as well as physical constraints and mapping evaluation. It is a broad representation of many aspects of work and analyses that were performed to ultimately arrive at the preferred transmission line projects presented in this report.

5.2 INITIAL TRANSMISSION EXPORT REVIEW AND ANALYSIS PROCESS

5.2.1 Existing Information Review

In order to fulfill the requirements to assess and recommend two to three transmission options that would provide additional export of renewable energy production out of Nevada to potential electric markets, an evaluation of the existing transmission grid and proposed projects that have been evaluated by NV Energy, the PUCN, and other regional transmission alternatives proposed by private transmission entities or other utilities were considered. As part of the overall evaluation process, a good deal of time was invested in a stakeholder collaborative process in Nevada in order to understand the regional renewable generation transmission needs. As discussed previously, RETAAC conducted extensive reviews and assessments pertaining to this very issue, and the resulting completed reports were fundamental in the initial process of this evaluation. The pertinent RETAAC mapping referenced for this study is included for reference in Appendix A.

The state of Nevada regulatory process requires that the state's two investor owned utilities (IOUs), Sierra Pacific Power Company (SPPC, DBA as NV Energy) and Nevada Power Company (NPC, DBA as NV Energy), develop and file for review and approval Integrated Resource Plans

(IRPs) on a triennial basis. This process has been in place since the 1980's and requires filing of significant transmission projects necessary to serve the customer loads in their respective service territories, as well as filing of transmission service for other wholesale customers as defined and administered by FERC.

The most recent IRPs filed with the PUCN are NPC's 2010-2029 Resource Plan, assigned docket #10-02009, and SPPC's 2011-2030 Resource Plan, assigned docket #10-07003. A full review of these filings was conducted and particular attention was focused on the "Renewable Conceptual Transmission Plan" section that was requested by the Nevada Legislature and filed as part of Docket #10-07003.

5.2.2 Electric Routing Objectives

Based on a thorough evaluation, incorporating knowledge of the existing system, technical transmission grid experience, and regulatory understanding, the following objectives were established:

- Identify specific transmission projects or improvements that would make optimum use of existing transmission facilities to fully utilize export from Nevada.
- Explore and evaluate new interstate transmission options that would significantly improve export paths directly or indirectly to California electric buyers.
- Identify the routing of transmission that would also provide key integration of transmission/distribution collector systems for renewable energy resource zones identified by the RETAAC initiative and reports.
- Give full consideration to transmission projects that can enhance the reliability of the transmission system and benefit overall transmission operation.

The work performed by RETAAC regarding renewable energy zone (REZ) descriptions and estimated resource generation values provided a strong place from which to start for this study. To the degree that NV Energy had provided transmission solutions in RETAAC, and filed IRPs, including the Renewable Conceptual Transmission Plan, the focus for this effort was to utilize and incorporate that existing planning information, apply a "fresh look" at the overall transmission planning picture, and ultimately select those projects that would yield the most expedient solutions to improving export out of Nevada to other electric markets for renewable generation.

Several projects, particularly in southern Nevada, that would relieve transmission congestion to allow transport of energy to the existing Alternating Current (AC) and Direct Current (DC) transmission corridors south of Las Vegas were not approved to proceed by the PUCN at this time, due primarily to the prioritized need at the time to focus on service to retail customers.

Load growth in the greater Las Vegas area, however, has not materialized as previously projected. Therefore, though a good deal of effort has been expended exploring and recommending solutions by the Grid Operators, no certainty to completion of proposed projects is assured.

In northern Nevada, Great Basin Energy Development, LLC Transmission has proposed a HVDC underground project from Tracy Substation to O'Banion Substation, south of Yuba City, California; and Lassen Municipal Utility District (LMUD) has proposed a project from Susanville (Viewland Substation) to Olinda Substation in North Central California. These projects are proposals by developers other than NV Energy (Grid Operator). Both of these projects are not directly influenced by any Nevada based transmission entity. The dilemma is that the transmission grid operator has no authority to construct for export and under FERC guidelines; a transmission project request requires contract commitments of the requesting party or parties. The nature of the development of renewable resources is incremental and not necessarily coincident in timing to provide aggregated need and commitment to solidify enough demand to move forward on proposed projects. It is a "catch 22" situation for all involved. This study effort is only the first part of the longer term solution. The business case for moving forward on the proposed projects will need to be developed once proposed project routes are determined.

Transmission projects proposed in this investigation focus on taking advantage of existing transmission facilities, as well as already proposed projects internal to the Nevada grid, which can help to accelerate the process of constructing interstate transmission improvements. The proposed projects in total will provide integration of renewable resources located in Nevada to the electric grid, as well as provide export paths to the neighboring electric markets.

5.3 ROUTING RATIONALE FOR ELECTRIC EXPORT AND GRID CONNECTIVITY

5.3.1 Renewable Energy Zones and Geographic Constraints

A major consideration for routing transmission lines from Nevada to California is the limited available possibilities to route and permit new transmission lines along the entire Nevada/California border. The fundamental problem is the extent of existing constraints. Geographically, these include the Sierra Nevada mountain range, extensive National Parks, Wilderness Areas, Wilderness Study Areas, highly sensitive land uses, and a sizeable concentration of Urban Areas that limit possible interstate transmission options. Taking these constraints into consideration, the Tri Sage team's focus for this study was to concentrate on examining alternatives that could avoid the obvious barriers yet have the greatest chance of being permitted. The following *Figure 5.1 - Physical Constraints Map of California-Nevada*

Border, provides a visual depiction of the extent of constraints along the Nevada-California border. As indicated, all identified constraints are shown in red, and represent the areas that would have either no, or extremely limited, opportunity for crossing.

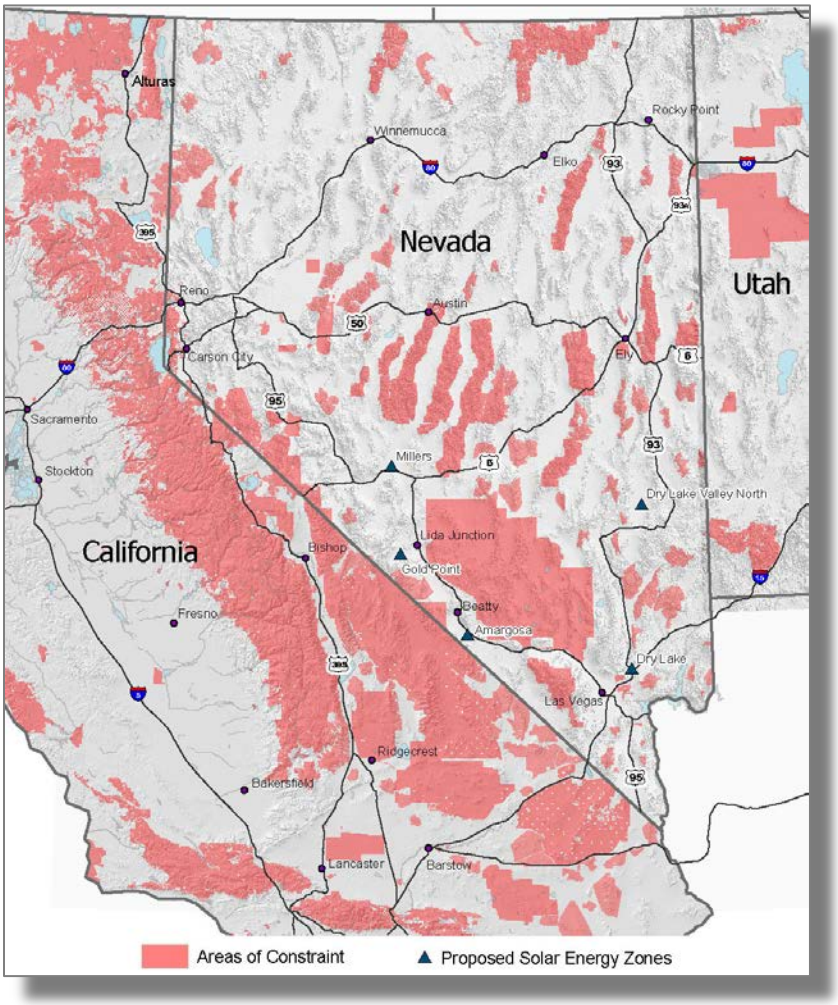

Figure 5.1 – Physical Constraints Map of California-Nevada Border

In addition to understanding the physical routing constraints along the Nevada-California border, it was critical to also understand how the REZs in the state are positioned so that they could be accessed to the greatest extent possible to allow for export of renewable energy into California. Again, taking advantage of work already performed and presented in the RETAAC Phase I & II Reports, the team reviewed the REZ mapping and overlaid the information onto the constraints mapping for this project. This combined mapping, shown in *Figure 5.2 – Physical Constraints with Renewable Energy Zones*, helps to show how the physical constraints impact the ability to develop transmission export from the REZs, particularly along the west and southwest borders of Nevada.

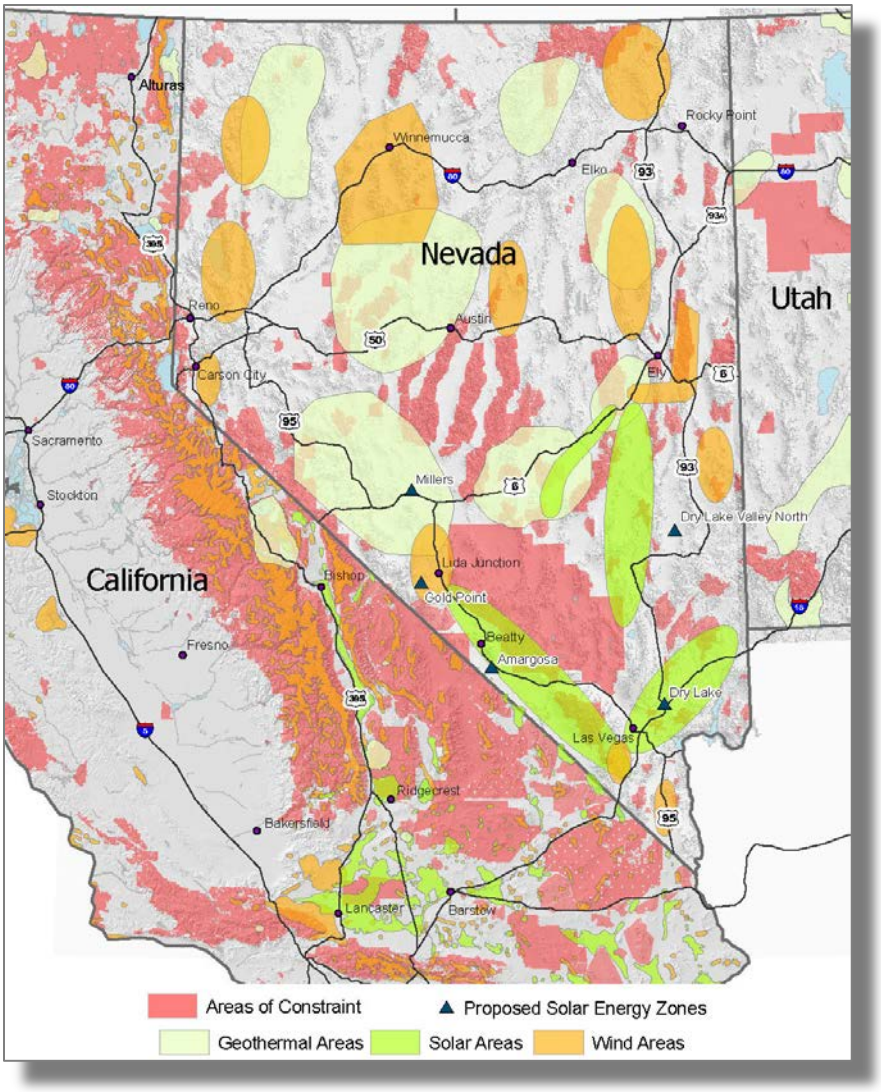

Figure 5.2 – Physical Constraints with Renewable Energy Zones

5.3.2 AC versus DC Export Consideration

In addition to physical constraints, consideration was also given to Alternating Current (AC) versus Direct Current (DC) for export lines. The evaluation of electric transmission lines generally considers the merits of designing and operating them as AC or DC, including the associated installed costs. DC transmission is an option that can provide superior benefits in some cases, primarily in underground or underwater long distance applications. The total line capacity for a given structure, conductor size and right-of-way width can be greater for DC operation. The line losses as a consequence of heat dissipation and corona effects are reduced for DC operation. The total installed cost can be evaluated between the two alternatives (DC or AC). The cost of the DC to AC converters at each terminal point adds significant additional costs to the DC alternative. The economics of reduced transmission losses and reduced cost/mile for

DC must be compared to the increased cost of converter stations and the potential impacts and mitigation of transmission interruption. In general, DC and AC systems are cost equivalent for lines of 500 miles in length. DC lines are generally a considered option when large generation capacity center output to large load centers are being transported over long distances. In many cases ideal utilization of DC configuration results when both ends of the line have large robust generation and loads tied to the other terminus that have similar electric generation and loads. This allows for optimum use of the transmission line for seasonal and operational exchanges of energy. It is critical that the transmission facilities at both ends are supported by strong AC systems, which provide technical and reliable operation of the interconnected transmission grid.

DC system integration can have serious system impacts to the AC interconnected systems. When the DC power transfer is interrupted, severe frequency and voltage problems can occur on the interconnected AC system at each end. This may require the interconnected systems to shed load to prevent damage to transmission components.

It is becoming more prevalent that DC transmission lines are constructed and operated with an intermediate three terminal electric configuration. Three terminal operation is where the transmission line has line terminals and DC-to-AC converters at both ends, and another terminal and converter intermediate to the line. This adds some intermediate interconnection capability but adds significant operational considerations.

AC transmission can readily be tapped with lower voltage interconnections at multiple points. This allows for the integration of renewable generation and service to new loads along the selected transmission path at reasonable costs. In the case of the proposed transmission projects in this report, the following discussion summarizes the merits for each project.

5.3.2.1 North Project

The North Project is approximately 126 miles in length and is proposed primarily to enhance the existing AC grid capability. Additionally, the North project is routed to provide the capability to act as a bulk collector for renewable resource generation interconnections.

5.3.2.2 East Project

The East Project is approximately 167 miles in length and could potentially be connected to the north end of the AC system that also includes an existing DC interconnection and line, from the Intermountain Power Project (IPP), near Delta, Utah to the Los Angeles, California load center. The proposed East Project does not have large concentrated generation, or a large load center at the west terminus; therefore, the additional project construction and operational costs of DC would not balance the increased potential line capacity benefits. Moreover, the potential of

ease of interconnection with other generation and transmission facilities along the line route could be practically accommodated if operated as AC.

5.3.2.3 South Project

The South Project is approximately 290 miles in length and has neither a large load center nor large concentrated generation at the north end of the project. Assuming a coincident collection of significant renewable resources at the north terminus (proposed Clayton Substation) could potentially provide some incentive to consider DC operation. However, a key consideration of the project was to allow for the ability to interconnect renewable resources located geographically near the proposed project route. The flexibility of AC transmission facilities over DC will add a more regional acceptability and support by stakeholders in both Nevada and California.

5.3.2.4 Summary

Though DC design, construction and operation were evaluated, the applicability to any of the proposed projects is not considered to be viable. Given the dispersed location and size of renewable generation, and the need for flexibility of operation, the projects herein are proposed as AC transmission facilities.

5.4 PROPOSED ELECTRIC INTERCONNECTION POINTS

Based on the above evaluation of physical constraints, locations of the viable REZs, AC verses DC transmission, and general experience in the region, the team identified nine possible routing options for crossing from Nevada into California that would allow for export into the California market. These routes were analyzed for both physical and electrical constraints. *Figure 5.3 - Possible Export Routes into California Market*, highlights these possible opportunities.

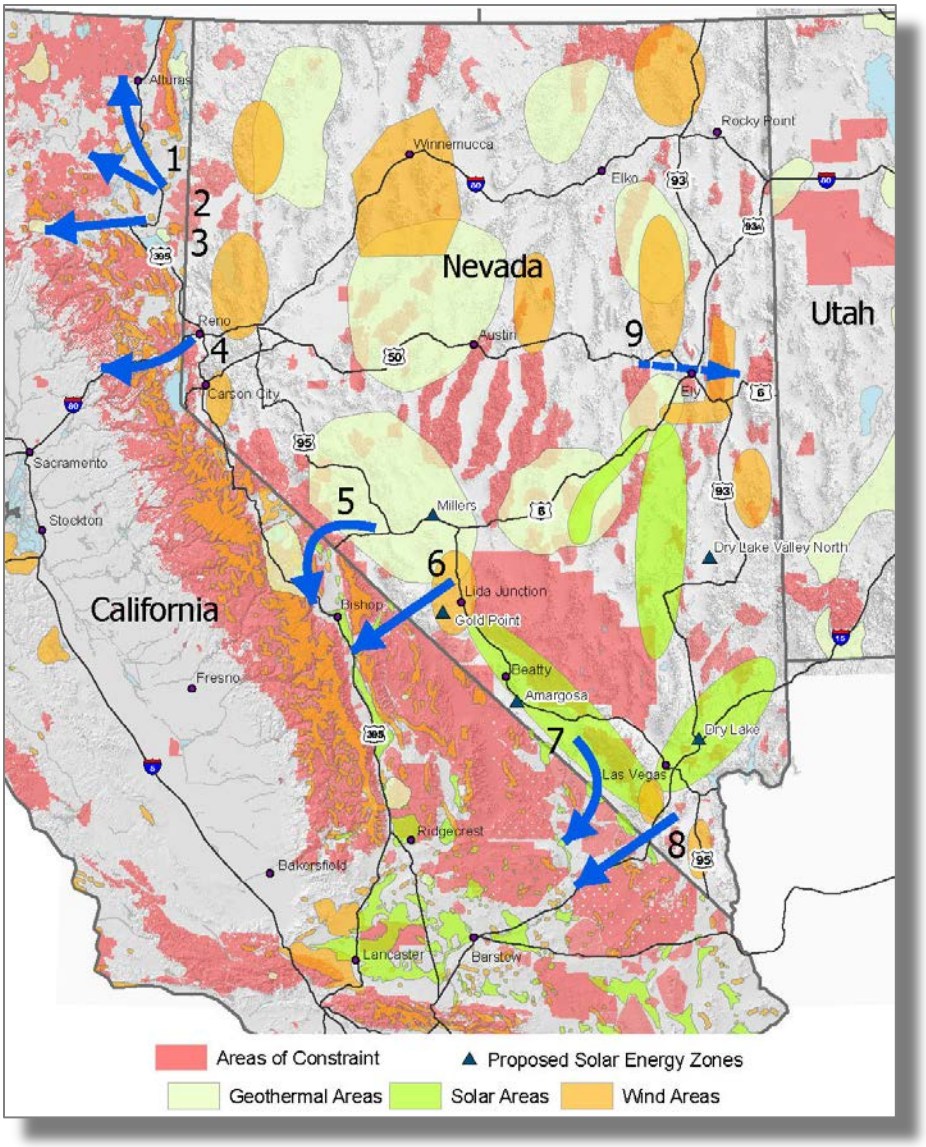

Figure 5.3 – Possible Export Routes into California Market

These nine routes were identified based on considerations of viability of permitting, strength of the interconnection into California, and physical limitations. From these identified possible routes into California, two viable routes were selected as proposed projects crossing the Nevada-California border. A third viable route was included that reaches the California market by way of going east out of Nevada into Utah. These three projects are discussed below as well as in the subsequent sections of this report. Section 6.4 specifically discusses the narrowing of the nine route opportunities to the three selected projects.

5.4.1 North Project

Based on identified transmission congestion around the Reno load center, the existing transmission lines from Tracy Power Plant located east of Reno, to the northern California-southern Oregon border (Reno-Alturas 345 kV line) are considered to be limited in export capability. Moreover, two projects, the Lassen Municipal Utility District (LMUD) proposed project from near Susanville, California directly west to north central California, and the Great Basin proposed high voltage direct current line from Tracy Generating Station to North central California offer potential solutions for increased export from Nevada.

Taking the transmission congestion issues in the Reno area into consideration, coupled with the possibility of building a significant project to act as the keystone for interconnection with identified REZs in northwest Nevada, a possible route was identified for constructing a new 345 kV transmission line, beginning north of Fernley, Nevada with interconnection into the existing 345 kV line that goes from Valmy Generating station, in north-central Nevada, to Tracy Generating station. The new interconnected line would then proceed north and northwest, and would terminate at a new substation proposed to interconnect with the existing Reno-Alturas 345 kV line, located northeast of Susanville at Viewland. This new proposed substation, Viewland Substation, is the beginning point of LMUD's proposed double-circuit 230 kV line; the termination point is Olinda Substation in north-central California.

In June 2011, NV Energy filed a request with the PUCN, assigned as docket #11-05002, which included proposals to build significant new transmission line projects to meet the need to interconnect renewable generation resource areas to the existing transmission grid (i.e. the RTI). One of the projects proposes construction of a new substation at Oreana, northeast of Lovelock, which would provide an opportunity to connect a 345 kV line from Oreana to Viewland, and this report reflects consideration of another possible North Project route alternative. This consideration resulted in the evaluation of two eastern terminus points for the northern route: North Fernley Substation and Oreana Substation.

5.4.1.1 North Project Objective

One of the goals of this transmission improvement is to integrate the generation of Wind Zone 6 & 7[1] and Geothermal Zone 2 generation. The possible MW potential generation in Geothermal Zone 2 is estimated at 108 MW[2]. The RETAAC Phase II study did not estimate the possible wind generation production for the wind zones. However, Wind Zone 6 did have 712 MW of projects in the SPPC Transmission Interconnection Study Queue in Sept. 2008[3]. On

[1] See RETAAC Phase II Study, page 33, for a map of Renewable Energy Zones.
[2] See RETAAC Phase II Study, page 40, for a table of possible generation values.
[3] See RETAAC Phase II Study, page 40, for a table of possible generation values.

October 17th, 2011 the SPPC Interconnection Study Queue contained approximately 750 MW of wind generation projects, which were judged to potentially benefit from the development of the North Project.

In summary, the objectives of the North Project are three-fold, in that it will:

- Provide a backbone collector system for northwestern Nevada renewable resources;
- Relieve congestion and increase firm transfer capability of the Alturas tie-line; and
- Provide another transmission source into Viewland Substation, facilitating future transmission projects from northwest Nevada to the northern California backbone transmission network.

5.4.1.2 North Project Technical Discussion

The North Project is a 345 kV transmission line originating from the Fernley or Lovelock area and terminating at Viewland Substation (approximately 40 miles NE of Susanville) on the Alturas Intertie. The following *Figure 5.4 - North Project Segments*, shows the proposed North Route broken into line segments. The electrical routing details are presented in this section, and the physical routing details are presented in Section 6. The following discussion presents the electrical grid issues that were considered to support this line route.

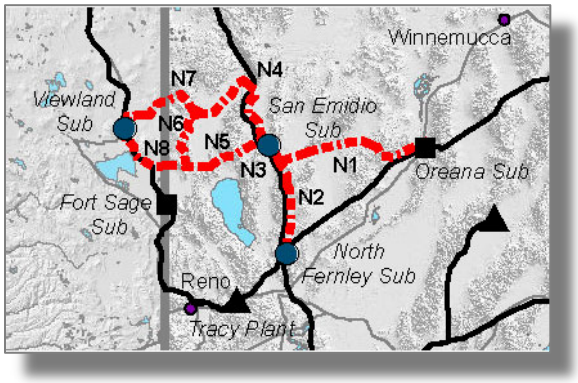

Figure 5.4 – North Project Segments

With 345 kV facilities present at both termini of the project, a 345 kV transmission line is a natural choice. Due to anticipated routing difficulties, the assumed line route will not traverse the valleys north of the Truckee Meadows and south of the Pyramid Lake Indian Reservation. While three alternatives were initially investigated regarding the southern/eastern terminus of the line, the alternative which involved the termination of the line at East Tracy Substation was abandoned due to congestion problems around East Tracy, leaving only two viable alternatives (North Fernley Substation and Oreana Substation).

The potential transmission interconnection locations (Substations) were initially considered based on improving transmission export out of northwest Nevada into California. Since it is known that LMUD is considering a new transmission project that interconnects with NV Energy's existing Alturas 345 kV line at Viewland, it was obvious to focus on constructing a project to that location. The other terminus was not as quickly identified. In the following discussion the alternatives are considered.

The North Project was initially studied with a new 345 kV substation in the area north of Fernley where the Pacific DC Intertie and the Valmy-Tracy 345 kV lines cross, at which point one or both of the Valmy-Tracy 345 kV lines could be "folded" into the new substation, referenced as North Fernley Substation. This alternative requires construction of a new 345 kV line from the North Fernley Substation north to the Gerlach area then northwest to the Viewland Substation in California.

The previously mentioned NV Energy PUCN Docket # 11-05002 describes a potential transmission addition of 39 miles of 345 kV transmission line from Dixie Valley to the existing Oreana Substation and then interconnecting with the existing Valmy-Tracy 345 kV transmission lines[4]. The Tri Sage team also considered an alternative that builds on these transmission additions by constructing a 345 kV transmission line from the proposed Oreana 345 kV Substation to the Gerlach area. This alternative, like NV Energy's line, also proposes to proceed west from the Gerlach area to the Viewland Substation. While both the North Project and LMUD's Project bring benefits on a stand-alone basis, the complementary nature of the projects would result in a significant multiplication of benefits if both were completed.

Surprise Valley Electric (SVE) is headquartered in Alturas California and has service territory in California, Oregon and northwestern Nevada. The southeastern portion of their service territory is only a few miles north of Gerlach, Nevada. Renewable resource development in SVE's service territory could be facilitated by utilizing the North Project to provide transmission services; another potential benefit of this Project.

5.4.1.3 Existing Alturas Intertie Capabilities

The Alturas Intertie is designated WECC Path 76[5]. The Alturas Intertie presently has a non-simultaneous import capability of 300 MW and non-simultaneous export capability of 300 MW[6]. SPPC's import nomogram posted on their Open Access Same-Time Information Site (OASIS), has Alturas flow on the horizontal axis. The flows for the Alturas Intertie range from

[4] See PUCN Docket #11-05002, page 5, paragraph 11a.
[5] See SPPC Integrated Resource Plan V10, page 62, for a paragraph description.
[6] See SPPC Integrated Resource Plan V10, page 62, for a paragraph description.

300 MW import to 50 MW export on the import nomogram[7]. Maximum system import is typically achieved with the Alturas Tie-line importing approximately 200 MW.

5.4.1.4 Existing Export Limitations

Operational limitations are usually the result of transmission system performance criteria being violated following N-1 single contingency transmission outages. Typical violations include: thermal overloads of remaining transmission elements, voltage falling below acceptable levels, the change in voltage exceeding the maximum acceptable voltage change, similar voltage problems only in the high direction, and cascading outages. When the Alturas Intertie is at or near its export capability limit, transmission flows are heavy in the east to west direction, from East Tracy Substation toward the Valley Road Substation in northwest Reno. For this condition, the worst single contingency is the loss of the East Tracy - North Valley Road 345 kV transmission line. Following the line trip, the power that was flowing on the 345 kV line redistributes to all remaining paths, with most of the power shifting to the most direct paths; in this case, the underlying 120 kV lines between East Tracy and Valley Road. When the underlying 120 kV lines reach their thermal overload rating, following the 345 kV line trip, that is the maximum reliable east to west transfer limit. *Figure 5.5 - System Overload Scenario A*, is a simplified one-line diagram of the Reno area transmission system, which depicts this scenario.

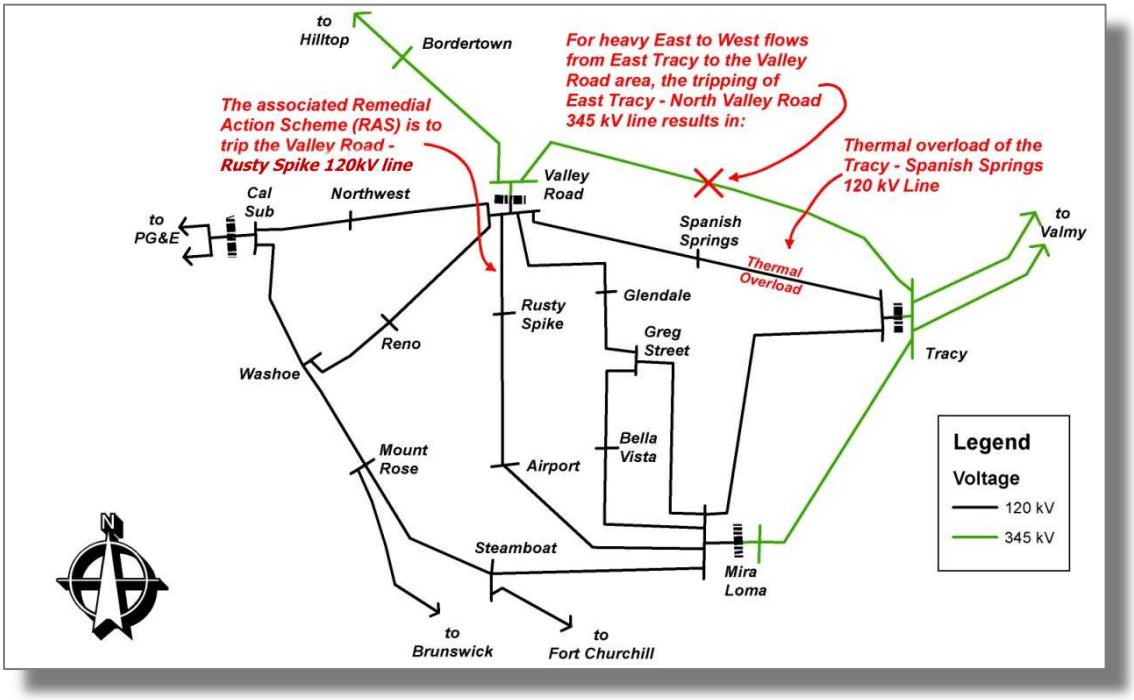

Figure 5.5 – System Overload Scenario A

[7] http://www.oatioasis.com/SPPC/SPPCdocs/Import_Nomograms_Scheduling_Summer_2004.xls

A remedial action scheme (RAS) is a course of action taken to relieve violations of the transmission system performance criteria. The RAS for tripping of the East Tracy-Valley Road 345 kV line for heavy east to west flows is to open the Valley Road-Rusty Spike 120 kV line. This action relieves the thermal overloads on the East Tracy-Spanish Springs-North Valley Road 120 kV line.

The SPPC IRP considers the Bordertown-Cal Sub 120 kV line an "initial" transmission solution[8]. With increasing loads, the IRP recommends the West Tracy-Ft. Sage 345 kV line as a solution. The North Project 345 kV line will have much the same effect.

5.4.1.5 Additional Modifications to Existing Grid

The existing Alturas Intertie has a 345 kV 300 MVA phase shifting transformer (i.e. a phase shifter) located at Bordertown Substation. Both the NV Energy-proposed West Tracy-Ft. Sage 345 kV Project and the North Project will require the relocation of the phase shifter to a point on the intertie north of the new Projects' termination points[9]. Without phase shifter relocation, the addition of either line would create a relatively low impedance loop around the Bordertown phase shifter, reducing its effectiveness and creating circulating power flow around the loop, increasing system losses unnecessarily.

5.4.2 East Project

Much like the opportunities offered by the proposed Valley Electric Association's (VEA) 500 kV project, an opportunity exists to move power from the north end of the ON Line project to central Utah allowing for export from Nevada to the southern California utilities that have transmission rights at IPP Substation and Mona Substation. The IPP participants include 36 independent entities that are all party to Intermountain Power Agency (IPA). There are specifically six southern California entities out of the 36 participants. To the degree that California utilities wish to displace existing resources (primarily coal based) in order to ship renewable energy south to southern California markets, Nevada based renewable project owners could execute contracts with southern California buyers and transport through the existing grid and out of the state, from Robinson Summit to IPP and Mona Substations.

Today, two 345 kV transmission lines connect the IPP substation to Mona Substation. Both were constructed as part of the IPP project, and as a result, are owned by the IPP project participants. It is our understanding that participants in the Utah energy markets indicate firm transmission capacity is currently available on these lines. Existing transmission rights at IPP and Mona are complicated making it unclear if it is necessary initially to build additional

[8] See SPPC Integrated Resource Plan V10, page 65.
[9] See SPPC Integrated Resource Plan V13, pages 17 & 18.

transmission facilities between IPP and Mona. This report performs limited analysis of an additional IPP to Mona transmission line for future construction as needed.

5.4.2.1 East Project Objective

One of the goals of this transmission improvement is to create additional export capability for the generation of Wind Zones 1, 2, & 3, Geothermal Zones 4 & 5, Biomass Zones 2 & 3, and Solar Zones 2 & 3[10]. The possible MW potential generation in Geothermal Zones 4 & 5 is estimated at 36 MW[11]. In the RETAAC estimates, the generation resources estimated from these zones range from 1,250 MW to 1,600 MW. As of April 15, 2010, interconnection requests indicate generation project developers' interest totaling approximately 1,060 MW of new generation[12].

In summary, the primary objective of the East Project is to:

- Provide unencumbered export capacity from eastern Nevada to Utah, ultimately to the California participants in the IPP.

5.4.2.2 East Project Description

The East Project can be either a 345 kV or 500 kV transmission line, originating at Robinson Summit Substation and terminating at IPP Substation. *Figure 5.6 - East Project Segments*, shows the proposed East Route broken into line segments. The following discussion presents the electrical grid issues that were considered to support this line route.

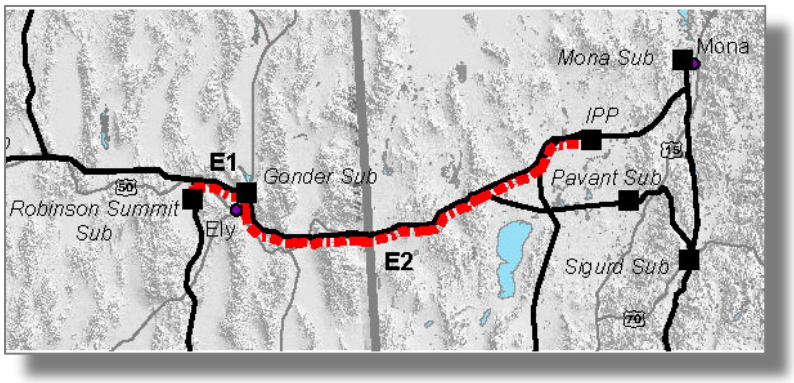

Figure 5.6 – East Project Segments

Following the completion of the ON Line project, Robinson Summit will have both 500 kV and 345 kV busses. Today, IPP does not have a 500 kV AC buss, but it does have a 345 kV AC buss.

[10] See RETAAC Phase II Study, page 33, for a map of Renewable Energy Zones.
[11] See RETAAC Phase II Study, page 40, for a table of possible generation values.
[12] See RETAAC V13, page 14.

The buss voltages anticipated to be available at the substations suggest two possible alternatives. The lower cost/lower capacity project is a 345 kV line from Robinson Summit to IPP. The higher cost/higher capacity project is a 500 kV project, comprised of a 500 kV line from Robinson Summit to IPP, and a 500/345 kV transformer at IPP. Additional transformer capacity may be required between the Fort Churchill Substation 230kV and 120 kV busses, and the Gonder Substation 345 kV and 230 kV busses to maximize the benefits of this project.

5.4.2.3 Existing Path 32 Capabilities

WECC Path 32 includes two transmission lines: Gonder-Pavant 230 kV & Gonder-Intermountain 230 kV lines. Total flow is rated at 440 MW in-bound and 235 MW out-bound[13]. The *WECC Path Rating Catalog* describes two different transformer overloads, following single contingency transmission outages, as the basis for the export limitation of 235 MW. Following the outage of the Valmy-Coyote Creek 345 kV line, an overload can occur on the Gonder 345/230 kV transformer. *Figure 5.7 - System Overload Scenario B*, depicts this line outage and resulting transformer overload.

[13] See SPPC Integrated Resource Plan V10, pages 61 &62.

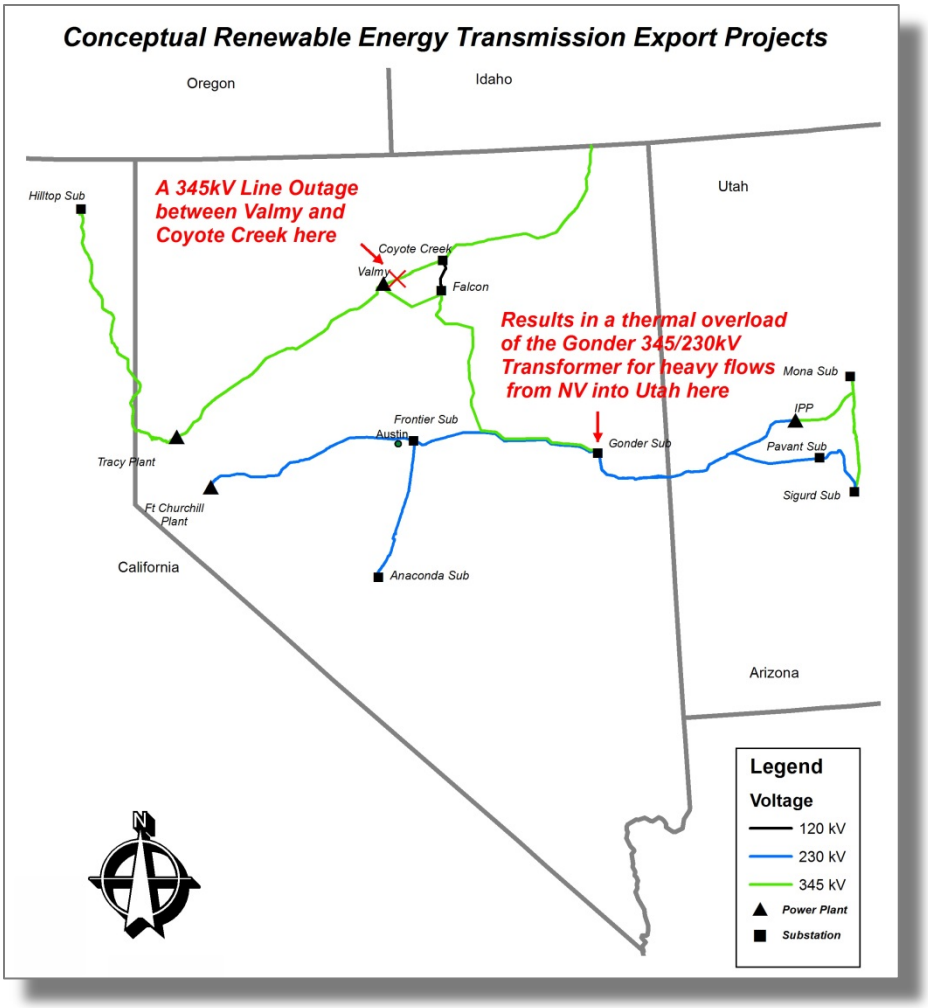

Figure 5.7 – System Overload Scenario B

Similarly, the outage of the Falcon-Gonder 345 kV line can result in the Fort Churchill 230/120 kV transformer being overloaded. *Figure 5.8 - System Overload Scenario C,* depicts this line outage and resulting transformer overload.

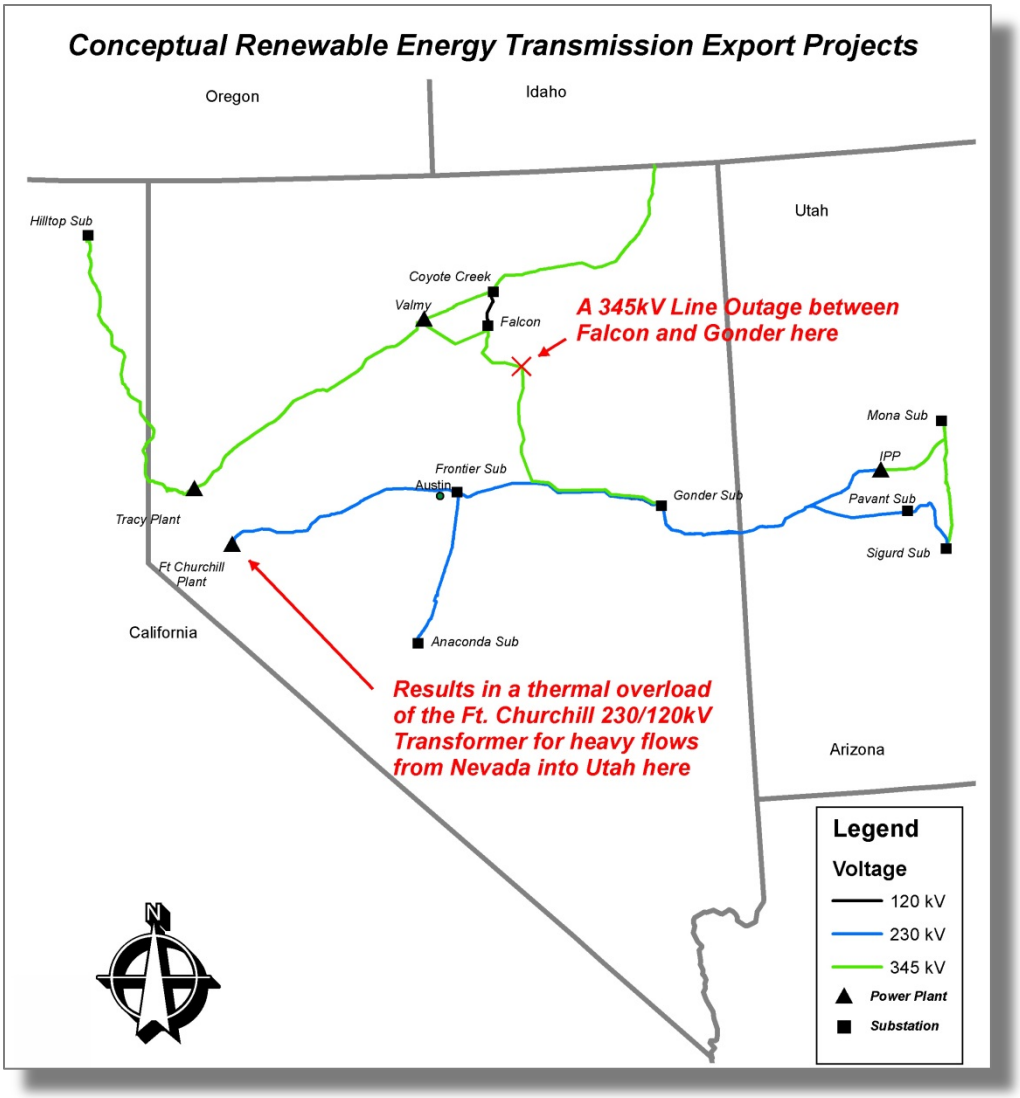

Figure 5.8 – System Overload Scenario C

5.4.2.4 Future Capacity Considerations

Any cursory attempt to quantify the increase in the export capacity of Path 32 following the addition of the East Project is very difficult and somewhat suspect for several reasons. While the existing Path 32 capabilities are known, NV Energy has not provided information describing the impact of the ON Line project on Path 32 ratings. In addition, today's export ratings are limited by the effects of electrically remote single contingency line outages resulting in transformer overloads on distant transformers not normally associated with Path 32 facilities.

5.4.3 South Project

The identified REZs located in west central and southwest Nevada in Nye, Esmeralda and Mineral Counties have little transmission capability to transport the magnitude of potential

generation resources. Significant effort has been made by Nye and Esmeralda counties, along with Inyo County in California, to pursue options for developing the renewable resources. The lack of transmission export options has hampered renewable generation development schedules. However, recent efforts, such as that by Valley Electric Association (VEA) to construct a double-circuit 230 kV line connecting with NV Energy's Northwest Substation will help to enable interconnect solutions for generation resources in lower Nye, Esmeralda and Inyo counties. Additionally, VEA announced their intent to construct a 500 kV line from Pahrump to Eldorado Substation with direct interconnect to existing California utilities. It is the understanding at the time of this report preparation that VEA has requested inclusion of the 500 kV substation near Pahrump into the CAISO. These significant projects will provide opportunities for development of Nevada based renewable generation projects within, or in close proximity to, the VEA service territory. This direct connection with California utilities provides access to California electric markets, which is dependent on the appetite of the California utilities to displace other energy purchases moved from the existing Eldorado Substation to the southern California transmission path (Path 46, as defined in the *WECC Path Rating Catalog*) and move the renewable energy output to California buyers.

The South Project is a solution for significant additional net export out of Nevada by way of a new high voltage transmission line from western Nevada south to southern California. This electric grid connection offers advantages to increase export out of Nevada in a location that can integrate well with existing transmission in Nevada and California and has a good possibility of be permitted. The siting of this line strategically allows for interconnections into renewable energy zones in upper Nye County, Mineral County, and west central Nevada. It also offers interconnections for California based renewable resources on the south California-Nevada border.

5.4.3.1 South Project Objective

One of the objectives of this southern transmission improvement is to integrate the generation of Wind Zone 8[14] and Geothermal Zone 3 generation into the western grid. Integration of the generation of Solar Zone 1 can also be accomplished with construction of either the RTI's Fort Churchill to Harry Allen transmission project or a transmission line, as proposed herein, from the Tonopah area to the VEA system. The possible MW potential generation in Geothermal Zone 3 is estimated at 288 MW[15]. On October 17th, 2011 the SPPC Interconnection Study Queue contained 110 MW of wind generation projects located in Nye or Esmerelda counties

[14] See RETAAC Phase II Study, page 33, for a map of Renewable Energy Zones.
[15] See RETAAC Phase II Study, page 40, for a table of possible generation values.

(Wind Zone 8). The possible MW potential generation in Solar Zone 1 is estimated at 4,168 MW[16].

An additional objective of this southern transmission improvement is to provide additional export capability from southern Nevada into the Los Angeles, California area. This could include energy transactions with the Los Angeles Department of Water and Power (LADWP) and Southern California Edison (SCE). Due to their geographic proximity, both Geothermal Zone 1 and Wind Zone 4[17] may benefit from the South Project. The possible MW potential generation in Geothermal Zone 1 is estimated at 362 MW[18]. On October 17th, 2011 the SPPC Interconnection Study Queue contained no wind generation projects located in Lander or Eureka counties (Wind Zone 4).

In summary, the objective of the South Project is to:

- Provide a backbone collector system for Nevada renewable resources statewide that can be viably interconnected and transported on NV Energy's system.
- Provide additional export capability from southern and central Nevada into the Los Angeles area.
- Capture California renewable generation along the southern California-Nevada Border.

5.4.3.2 South Project Transmission Technical Discussion

The South Project is proposed to be a 500 kV transmission line originating in the Tonopah, Nevada area and terminating in the Los Angeles area. The following *Figure 5.9 - South Project Segments*, shows the proposed South Route broken into line segments. The electrical technical routing details are presented in this Section, and the physical routing details are presented in Section 6. The following discussion presents the electrical grid issues that were considered to support this line route.

[16] See RETAAC Phase II Study, page 40, for a table of possible generation values.
[17] See RETAAC Phase II Study, page 33, for a map of Renewable Energy Zones.
[18] See RETAAC Phase II Study, page 40, for a table of possible generation values.

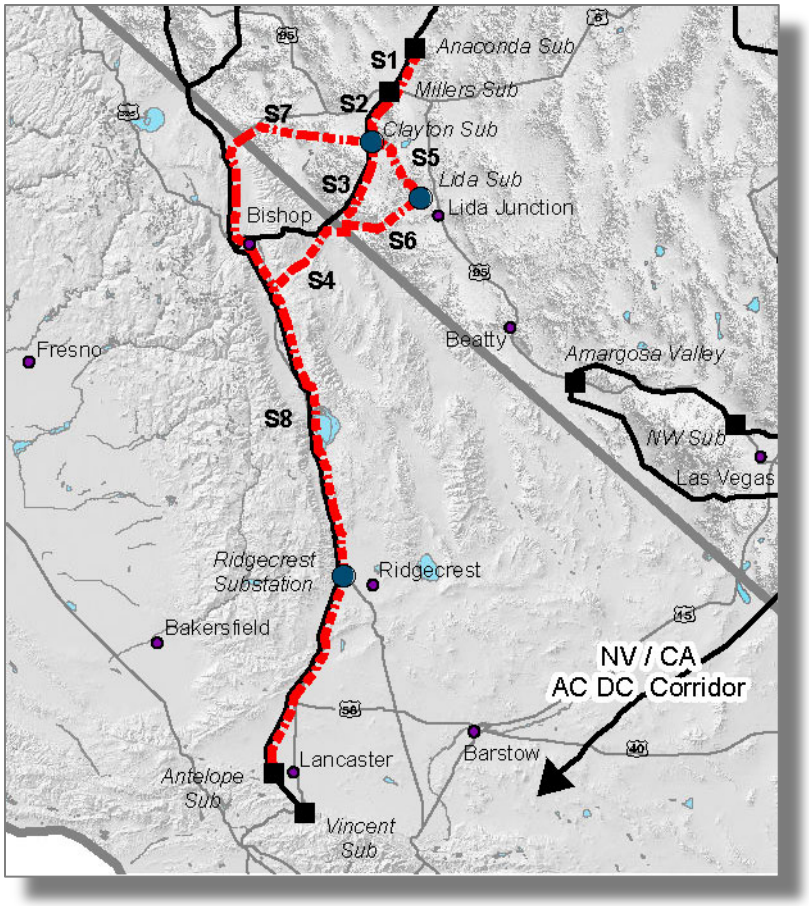

Figure 5.9 – South Project Segments

Initial consideration was given to a prospective interconnection location within the NV Energy transmission system and a sufficiently robust grid location in the southern California transmission system. It was critical to first consider the electric market opportunities and electrical grid strength, and also consider the critical aspects of potential physical routing.

In PUCN Docket #11-05002, NV Energy describes 498 miles of potential transmission improvements associated with their Renewable Transmission Initiative (RTI).[19] The transmission projects proposed in RTI will be dependent, as fully described in the RTI documentation, on the level of market interest. The proposed South Route herein offers not only new export for Nevada but would also enhance the RTI export opportunity. Several northern terminus alternatives exist for the configuration of this proposed route. These alternatives address the uncertainty surrounding the RTI "West Tie-South" project, specifically from Ft. Churchill Substation to the Harry Allen Substation.

[19] See PUCN Docket #11-05002, page 5, paragraph 11b.

Northern Terminus if the "West Tie-South" is Completed

If the RTI "West Tie-South" project is constructed, the northern terminus of the South Project should be located at the proposed Lida Substation, south of Tonopah. The proposed location of Lida Substation is approximately 9 miles northwest of the junction of State Route 266 and U.S. Highway 95. If the West Tie-South project is a 345 kV project, a 345 kV to 500 kV transformer will be required to interconnect the two projects.

Northern Terminus if the "West Tie-South" is not Completed

If the RTI "West Tie-South" project is not constructed, the Anaconda-Moly 230 kV Substation is the most southern location of NV Energy's existing northern 230 kV transmission facilities. For this reason, Anaconda-Moly 230 kV Substation is the obvious location to interface the South Project with the existing NV Energy transmission system. Since the South Project is a 500 kV project terminating at a 230 kV substation, a 500 to 230 kV voltage transformation will be required. The Clayton Substation is a prudent location for the 500/230 kV transformer. If the RTI "West Tie-South" project is constructed at a later date, the 500 kV South Project can interconnect with no low voltage connections to reduce transfer capability. A new 230 kV transmission line from Anaconda-Moly Substation to Clayton Substation will be required. This line and the existing 120 kV system in the Miller's Substation area have potential to serve as collector systems for renewable resources in the area.

It should be noted that presently the TerraGen 230 kV transmission line and the Ft. Churchill-Austin 230 kV line cross in this area without any interconnection. While the South Project as described in this report does not contemplate an interconnection with this TerraGen line, potential interconnection benefits should be investigated during the WECC rating and final design phase. This line upgrade was not investigated during this study due to the associated extensive system upgrade requirements in the SCE system. In addition, based on previous experience with this facility, such an interconnection (including all associated upgrades) would only increase export capacity by a small amount compared to the proposed South Route.

Clayton was established as a northern 500kV termination point. The process then focused on the possible southern termination point(s). Consideration was given to include potential collector substations near the southeast California-Nevada border to serve renewable energy zones in that area.

The southern terminus of the line is flexible; however, the Antelope Substation (approximately 8 miles west of Lancaster, California) was identified as a probable choice. By interconnecting into the Antelope Substation area, the renewable power export will reach a less constrained segment of the California grid, which is on the northern side of Los Angeles

and also taps into the SCE grid. The Antelope Substation includes two existing 500 kV and three 230 kV transmission lines connected to the load centers. Under separate cover, the Tri Sage team has presented the process that is necessary to complete the transmission planning studies required to substantiate the viability of this substation as the southern terminus. This should be considered a next step action.

With the South Project endpoints established to be the northern Los Angeles and Tonopah, Nevada areas, the most promising routing for the line was thought to be parallel to the existing transmission lines in the Owens River valley.

In the absence of the RTI "West Tie-South" project, a future expansion of the South Project should be considered as a 500 or 230 kV line, from Clayton Substation to the VEA system, since VEA has announced plans to extend 500 kV from Eldorado Substation northwest to the Pahrump area. A discussion of the routing details is presented in Section 6.

Project Benefits

The benefits of this proposed line alternative are multi-fold. Specifically, this line will:

- Increase reliability to both the CAISO and NV Energy grids;
- Open up a new path for renewable energy export from Nevada; and
- Allow for interconnections mid-line in California.

5.5 PRELIMINARY TECHNICAL PARAMETERS

Once the termination points were established, and it was confirmed that viable routes existed for the interconnections, a high level evaluation was conducted to consider the thermal ratings of each proposed project alternative. Thermal rating is the rating of the physical line considering the conductor type and other physical line components. The conductor configuration chosen is on the smaller end of the spectrum for thermal rating purposes but large enough to support the projected export path ratings. Once a specific project is chosen and it enters into a detailed evaluation and design phase, a detailed conductor study, in conjunction with a detailed structure study, should be undertaken to compare the various alternatives against the overall project economics. This detailed conductor study would also include the effects of line losses, corona, radio interference, etc. on the final conductor configuration chosen.

While the thermal rating provides the capacities available on the various lines, another rating is also required. WECC requires that, prior to allowing any transmission line to be energized, it must receive a line rating from the applicable WECC Subregional Planning Group. In the case of these lines, this group is the Sierra Subregional Planning Group (SSPG). This WECC rating is

required in order to allow the planning groups the opportunity to evaluate the impact of a proposed transmission line on the entire western electric grid. As such, the thermal rating of a line is usually higher than the WECC rating of a line.

The final WECC ratings are issued after an extensive rating process. This process should be considered by NEAC as one of the next steps for this project. For reference purposes, basic assumptions have been made by the team and estimated ratings have been established to provide a guideline of the opportunity for export on these proposed transmission lines. It is critical to note that this information is preliminary and subject to the final WECC review and approval process.

The following tables and associated notes provide the details for the proposed projects. A summary of this data is provided in *Table 1.1 – Projects Summary of Costs and Ratings*, of Section 1, Executive Summary, and is discussed further in Section 8, Report Conclusions and Recommendations.

Proposed North Project – Oreana to Viewland

Approximate Line Length	Voltage	Conductor Configuration	Thermal Rating	Projected Export Path Rating
126	345 kV	2 - 954 MCM	1240 megawatts	70 megawatts [(1)]
LMUD/WAPA Project Only				500 megawatts [(2)]
126	345 kV	2 - 954 MCM	1240 megawatts	1000 megawatts [(3)(4)]

Table 5.1 – Thermal Rating Summary for North Project

Notes & Clarifications:

1) Proposed Project or RTI Proposed Project Completed & LMUD/WAPA Double Circuit 230 kV Project Not Completed.
2) LMUD/WAPA Double Circuit 230 kV Project Completed & Proposed Project or RTI Proposed Project Not Completed.
3) LMUD/WAPA Double Circuit 230 kV Project Completed & Proposed Project or RTI Proposed Project Completed.
4) Either the completion of the Proposed RTI or Proposed North Projects has significant internal grid system benefits. The proposed North Project route will reduce the collector system transmission requirements for serving the Renewable Energy Zones in northwest Nevada and northeast California.

Proposed East Project – Robinson Summit to IPP (1)

Approximate Line Length	Voltage	Conductor Configuration	Thermal Rating	Projected Export Path Rating
167	345 kV	2 - 954 MCM	1240 megawatts	400-600 megawatts
167	500 kV	3 - 954 MCM	2690 megawatts	750-1000 megawatts

Table 5.2 – Thermal Rating Summary for East Project

Notes & Clarifications:

1) This proposed project is highly dependent on Available Transmission Capacity (ATC) being available for potential buyers at IPP. It is likely that once the California Renewable Portfolio Standard is fully implemented many southern California buyers who hold the ATC will be interested in taking deliveries at IPP.

Proposed South Project – Anaconda-Moly to Clayton Substation to Antelope (no RTI)

Approximate Line Length	Voltage	Conductor Configuration	Thermal Rating	Projected Export Path Rating
253(1)	500 kV	3 - 954 MCM	2690 megawatts	750-1000 megawatts (4)
37(2)	230 kV (3)	1 - 954 MCM	410 megawatts	N/A

Table 5.3 – Thermal Rating Summary for South Project (Anaconda-Clayton-Antelope) - No RTI

Notes & Clarifications:

1) The line from Clayton Substation to Antelope Substation is approximately 253 miles long.
2) The line from Anaconda-Moly Substation to Clayton Substation is approximately 37 miles long.
3) Proposed Project includes the 230 kV transmission tie from Anaconda-Moly Substation to Clayton Substation but the path rating will be dependent on the 500 kV from Clayton to Antelope Substation.
4) This would require some level of high-speed transfer tripping of the connected generation on the line to support the rating.

Proposed South Project – Anaconda-Moly to Clayton Substation and Antelope; includes segment from Clayton to Pahrump 500 kV Substation (no RTI)

Approximate Line Length	Voltage	Conductor Configuration	Thermal Rating	Projected Export Path Rating
253[(1)]	500 kV	3 - 954 MCM	2690 megawatts	1500-2000 megawatts [(5)]
174[(2)]	500 kV	3 - 954 MCM	2690 megawatts	Included Above
37[(3)]	230 kV [(4)]	1 - 954 MCM	410 megawatts	N/A

Table 5.4 – Thermal Rating Summary for South Project (Includes Segment to Pahrump) – No RTI

Notes & Clarifications:

1) The line from Clayton Substation to Antelope Substation is approximately 253 miles long.
2) The line from Clayton Substation to Pahrump Substation is approximately 174 miles long.
3) The line from Anaconda-Moly Substation to Clayton Substation is approximately 37 miles long.
4) Proposed Project includes 230 kV transmission to tie from Anaconda-Moly Substation to Clayton Substation, but the path rating will be dependent on the 500 kV from Clayton to Antelope Substation & the 500 kV from Clayton to Pahrump 500 kV Substation.
5) This would require some level of high speed transfer tripping of the connected generation on the line to support the rating & would likely require that approximately 50% of generation be scheduled to Antelope and 50% to Pahrump 500 kV Substation, and then to the Eldorado Substation.

Proposed South Project – Lida Substation to Antelope (with RTI) (1)

Approximate Line Length	Voltage	Conductor Configuration	Thermal Rating	Projected Export Path Rating
251	500 kV	3 - 954 MCM	2690 megawatts	750-1000 megawatts [(2)]

Table 5.5 – Thermal Rating Summary for South Project (Lida-Antelope) – With RTI

Notes & Clarifications:

1) This could be Clayton to Antelope as well, since the line mileages are comparable. There are other reasons to consider locating the substation at Lida.
2) This would not likely require high speed transfer tripping of the connected generation on the line to support the rating.