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Nevada Hydro Whitepapers addressing Southern California Transmission and Reliability

The Nevada Hydro Company has prepared a series of Whitepapers addressing Southern California transmission and reliability issues for consideration in this proceeding.

These Whitepapers are attached. Our team is happy to discuss any issue raised in these Whitepapers with Commission staff or proceeding participants.

This is the second of three filings.

Additional submitted attachment is included below.

Future Transmission Needs in Southern California

Thoughts on the CAISO's Draft 2013–2014 Transmission Plan

The Nevada Hydro Company
February, 2014

This is the second in a series of Whitepapers providing the views of The Nevada Hydro Company and its experts on issues relating to the state of the high voltage grid in Southern California.

I. "The Perfect Storm"

Long-term system planning requires persistent diligence to the many details to keep the electric power system of Southern California operating reliably and cost-effectively. However, even with the best intentions, there are times when well-developed plans do not produce the needed results. Usually this is due to reasons beyond the planner's control. Just such a situation began to unfold in 2008 and continues today.

The first event that marked this gradually developing problem was the decision by the Arizona Corporation Commission to deny Southern California Edison ("SCE") permission to build the second Palo Verde-Devers 500 kV transmission Line. This reduced the ability of the system to move power from Arizona to Southern California by over a thousand megawatts. A secondary outcome of this action was the likely denial of adding a second 500 kV line from North Gila to Imperial Valley.

The next event to affect the system's development was the decision that disallowed the 500 kV Sunrise Powerlink to follow a route that would widely separate it from the Southwest Power Link as it leaves the Imperial Valley Substation. While the need for both lines to traverse west from Imperial Valley into San Diego's load area was desirable, the close location of the two lines' right-of-way for their first 33 miles increases the likelihood of both lines being out of service at the same time.

The next factor in causing reduced reliability in the area was the decision of the California Water Resource Control Board to require mitigation of once-through-cooling water flows for generation on the Pacific Ocean coast. This mitigation is essentially impossible, so by approximately 2020, several currently operating generating stations will have been retired. There will be some replacement generation built for these plants, but, for the most part, the net reduction in generation will be in the order of five thousand megawatts. Most of this soon-to-disappear power supply will be along the western edge of the Los Angeles Basin. Thus, for the L.A. Basin, a major increase in power needed to serve the area will have to come from the east. In addition, with the shutdown of Encina Station in San Diego and at best only partial replacement coming from the new Carlsbad Energy Center, San Diego Gas & Electric ("SDG&E") will have its generation within the San Diego load area reduced by about twenty percent. This will also require more power from the east.

Then came the retirement of the San Onofre Nuclear Generation Station ("SONGS"). The SONGS units had served as a linchpin of support and low-cost electricity for decades. Now they are gone. This has reduced the strong system reliability support the units previously provided. Having served somewhat like a clothesline pole keeping the laundry from dragging on the ground, now there is a point of difficulty where once there was stalwart support.

Overall, this collection of events has left the southern California area well below the level of reliability required by NERC and WECC. While the load in SDG&E and SCE continues to grow, the level of generation has already declined, and will decline even further in the next half decade.

II. What to do to meet the need

No longer can the region's utilities lean with easy dependence on a few assets. Building replacement generation on the western edge of the area is virtually impossible besides being expensive to build and operate. In addition, most of the utility-level renewable power supplies are located well to the east of the area. Testing what new transmission may do to bring system reliability back to compliance shows that continued expansion of the area's 230 kV transmission is not up to the task. Testing of the reactive power losses that result from major contingencies show that the reactive power losses on the 230 kV lines far exceed the normal reactive power these lines naturally produce. The California ISO has hinted at this situation in the Forward of its draft 2013-2014 Transmission Plan.

> *The 2013-2014 Transmission Plan has a number of unique challenges due to the issues being addressed in this year's plan that are requiring some additional flexibility in the presentation of this year's draft transmission plan:*
>
> *1. Unprecedented levels of uncertainty about the development of non-transmission resources*
>
> *2. Transmission solutions that are pushing the boundaries of optimizing existing assets and require extensive implementation coordination with neighboring systems.*
>
> *3. Tackling new issues in hardening the system for extreme events in response to growing concerns over wider ranges of risks the transmission system may be exposed to.*[1]

CAISO's second point is especially important with regard to the need for new thinking on a broader scale than has been evident in recent years. While CAISO recommends in this plan a limited number of what are called "Group I" projects, all of these projects are admitted to not be able to bring the system into reliability compliance in the next five to seven years.[2] Nor are

[1]/ CAISO, "Draft 2013-2014 Transmission Plan", February 3, 2014

[2]/ CAISO Draft Transmission Plan 2013-2014, p. 104, "These recommendations do not address all of the requirement identified for the San Diego and LA Basin area; they result in a residual need of up to 900 MW overall for those areas, assuming conservative estimates for their overall effectiveness and based on the

they particularly timely or inexpensive. The ISO estimates that two of the three recommendations are to enter service in 2018 and the third in 2020. The CAISO has estimated the total cost for these projects to be between $870 million to $1.08 billion. And its proposals for the "Group II" and Group III" projects with the exception of Nevada Hydro's Talega–Escondido/Valley–Serrano 500 kV Interconnect Project are vague and couched in terms of long-term fruition. The problem is that the area needs solutions to its reliability problems now, and denials, no matter how fervent or well-articulated, is not a good engineering or political solution.

III. System Blackout of September 8, 2011

The system blackout of September 8, 2011 was an important wakeup call to WECC, CAISO area utilities and those they serve. In its report, "FERC/NERC Staff Report on the September 8, 2011 Blackout", the staff of these national regulatory bodies conducted an intensive review of the operating and planning practices of the responsible bodies in southern California and WECC. The report draws parallels between the August 2003 blackout in the northeastern U.S. and this event. The report states,

> *"Similarly, this inquiry's report found that several entities' operational and long-term studies did not adequately ensure the reliable operation of their systems. Specifically, both reports described relevant planning studies that: (1) did not adequately identify and study critical external facilities; (2) did not adequately analyze potential contingency scenarios; and (3) were based on inaccurate models and invalid system operating limits (SOLs)."*[3]

An important finding highlighted by this report was that the system fell victim to a single (N-1) loss of a 500 kV facility, the 500 kV line between Hassayampa and North Gila. The line's loss was not the entire story, but in the process, it exposed a multi-layered set of other issues that had not been properly addressed. That event should have been handled with no loss of customer load is obvious, but that event uncovered a long string of poorly managed incipient problems resulting in a system collapse.

An important consideration is the balance between the responsibilities of the planners and those of the operators. It is possible to design a system that with perfect operation could survive the vagaries of chance events. However, that places a huge burden on the operators of such a system. Make any mistake and it will appear on the headlines of tomorrow's newspaper. Conversely, one could plan and install a system, at possibly huge expense, that could survive almost any operator's competence. Some balance must be struck.

One of the interesting considerations in the northeast blackout of 2003 was where the breakpoints between areas with and without service occurred. The system broke down at the

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resource assumptions discussed earlier. The residual need leaves room in future planning and procurement cycles to take into account changes in load forecasting as well as anticipated increases in forecasts for preferred resources – energy efficiency in particular."

[3]/ "FERC/NERC Staff Report on the September 8, 2011 Blackout", P. 125

transition points from the AEP 765 kV system and the underlying 345 kV system. Although this is not exactly true in the case of the 2011 southern California blackout, it has become evident through power flow studies that the same issue of transmission voltage level applies to California as well. The 230 kV transmission system, while an extensive and robust system for real power flow, has serious limitations in its ability to maintain voltage under adverse conditions. Thus, CAISO has recommended the addition of large blocks of capacitive reactance (capacitors) in order to support voltage under high reactive power (Var) consumption situations, or flow controls which are expensive at best and hazardous otherwise. This is part of its efforts to manage performance with existing system elements rather than take steps to move beyond “managing the status quo”. CAISO has hinted at its concern about this form of system control, but has not stepped up to an updated view. The FERC/NERC study hints at the need to move toward a new look at how to deliver power from source to consumer.

IV. The Future Scene in Power Delivery

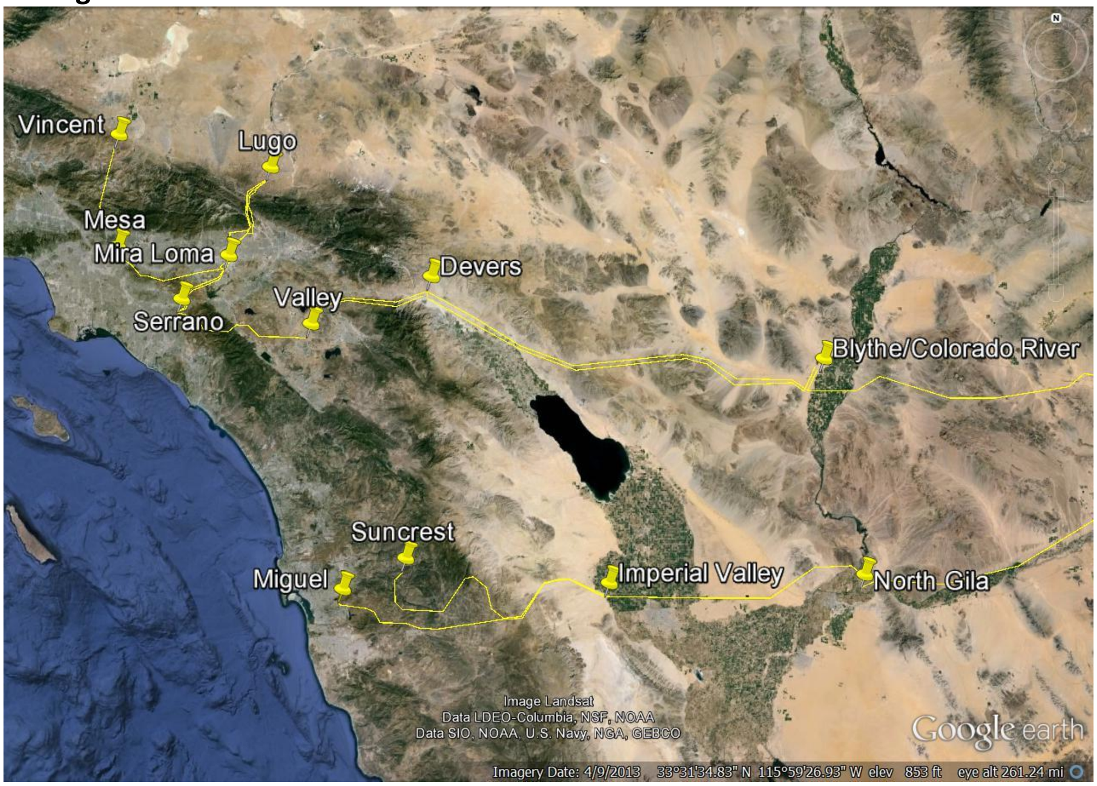
The actions of SCE in retiring SONGS and the State’s Water Board on once-through-cooling mitigation will push large amounts of power production away from the coast over the next five to eight years. This will move the resources to provide for Southern California back from the Pacific coast and make their delivery more dependent on adequate and more flexible transmission. The primary issue will be the need for more 500 kV transmission further into the region coming from the areas where new renewable and gas-fired generation will be built. CAISO has identified these transmission needs in their draft 2013–2014 Transmission Plan (“Draft Plan”), but has come away with no firm plans on how to meet the needs found. For example, many of the mitigation plans in Appendix C of the Draft Plan describe a “Post-SONGS Transmission Strengthen Plan TBD”, which leaves the solution unknown or hopeful at best. Further, there are missed system performance changes coming as part of the SONGS retirement that the planners have not grasped. As an example of this missed limitation is the inclusion of the ratings of WECC Paths 43 and 44 near SONGS at their levels before the retirement of SONGS as shown in Table 2.3-5. This is an example of the complexity of planning in this area, with the prospect of missed understandings of limits, which could lead to the kind of disaster noted in the FERC/NERC report.

Shown on Figure 1 – Points of Maximum Penetration of 500 kV in Southern California are the present points of maximum penetration of 500 kV delivery into the L.A. Basin and San Diego extracted from Google Earth. The yellow pushpins represent the 500 kV substations and 500 kV lines are shown in yellow.

As Figure 1 shows, there are no 500 kV substations or lines between Valley and Serrano on the north, and Miguel and Suncrest to the south. Approximately 25,000 MW of heavy summer load lies between Serrano and Valley in the north and Suncrest and Miguel on the south. The direct distance between Valley and Suncrest is 70 miles.

There is no 500 kV path between the northern and southern 500 kV substations except via the path that extends back to Palo Verde in Arizona. The proposed Mesa Substation loop-in is shown, even though it is not to be in service until 2020.

Figure 1 – Points of Maximum Penetration of 500 kV in Southern California



Source: The Nevada Hydro Company

With the absence of the real and reactive power supply from SONGS, there is now a gap in transmission service that had been supplied by a combination of 230 kV transmission and generation located along the Pacific Coast. While the load continues to grow, the ability to supply power to that load has decreased and will decrease even more over the remainder of this decade as a result of once-through-cooling-driven retirements. Some replacement central station generation will be added and distributed generation and load management actions will increase, but will not match that which is going away. A review of the WECC power flow system summary for SCE shows system reactive power losses (MVAR) compared to the line charging, even under normal, no contingency conditions, and shows how much reactive power losses impacts the ability to manage voltage. Moreover, there is some question about whether the SCE system load at 66 kV does in fact have a positive power factor on peak as modeled in the CAISO's future load flow cases. Noting that reactive power losses increase with the square of the current flow, and that the ratio of reactive impedance to resistive impedance is about eight to one, contingency conditions consume very large amounts of reactive power. The reactive power losses versus charging on 230 kV lines compared to 500 kV lines is much higher.

The need for new 500 kV transmission into the L.A. Basin and San Diego has now reached a critical point. The system cannot meet its reliability requirements now, as it has not since SONGS shut down. Only the absence of a critical outage has permitted the lights to stay on. But that is not satisfactory planning. While CAISO, SCE and SDG&E have been avoiding speaking about this dilemma in public, for a range of economic, public safety and prospective embarrassment issues, they have proposed a collection of solutions that do not meet their own reliability standards. They are seeking further plans that meet their own internal vision while seemingly holding the areas they serve unaware of the potential of another system failure.

V. Prospective Solutions from Inside and Outside the Utility Bubble

The ability to bring the southern California area electric utility system back into its required reliability standards will be a multi-step process. There have been a number of unsuccessful attempts to provide the 500 kV system integration needed. One was the Valley-Rainbow Project proposed approximately 15 years ago. A second was the Green Path North Project, and there have been other ideas that have not gained access to discussion by the wider utility community. But, the fact that these two projects were considered, reflect the growing awareness that closer integration of the system at 500 kV was needed. The situation is even more urgent now.

There is a need to move as quickly as reasonably possible on those projects that can be set in place first. What follows moves from the most quickly implementable to the more "Blue sky" following the assumption that all of CAISO's Group I projects are in place.

A. Talega-Escondido/Valley-Serrano Interconnect Project

1. Base Project

The first step of the Talega-Escondido/Valley Serrano (TE/VS Interconnect) Project is a 500 kV line proposed between SCE's proposed Alberhill Substation (or near its location if the proposal is not approved) and a point on the existing 230 kV Talega-Escondido line in SDG&E's territory above Camp Pendleton. The southern end of this part of the Project is at the proposed Case Springs Substation. This is about 32 miles, and passes the site of the proposed 500 MW Lake Elsinore Advanced Pumped Storage Project.

At the case Springs Substation, there are three steps:

1. Install three strings of 500/230 kV transformers and phase shifting transformers.
2. Reconductor the existing 230 kV line from Talega to Escondido for double-bundled service.
3. Add a second 230 kV double-bundled circuit on the same existing towers between Talega, Case Springs and Escondido

This is the well-studied base TE/VS Interconnect configuration. Under this option, in-service is early summer 2016.

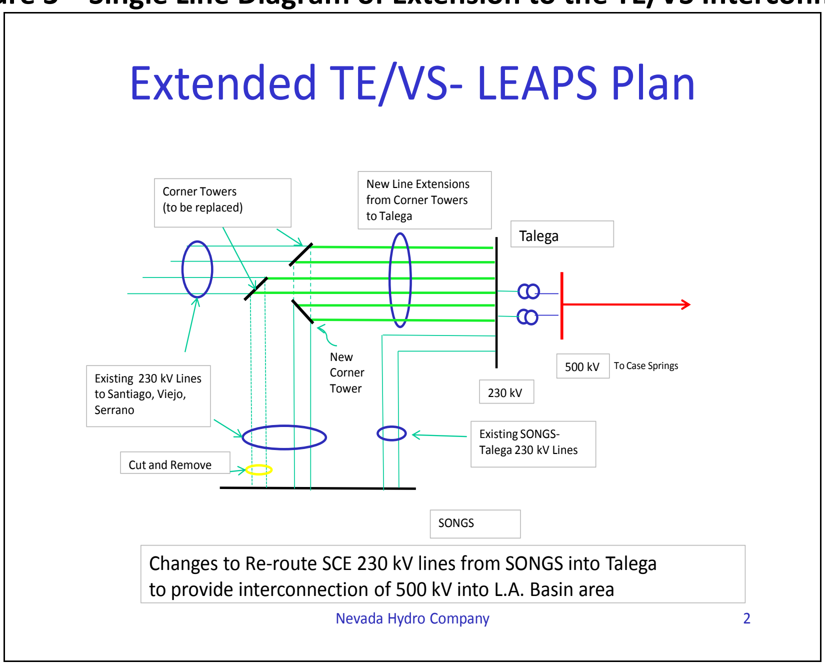
2. Extensions to the TE/VS Interconnect

The corridor between Talega and Escondido has long been permitted for use at 500 kV. This alternative involves the development of the corridor for that voltage. SCE and/or SDG&E will likely undertake this project. Case Springs Substation on the TE/VS Interconnect would become essentially a tee-point. This alternative involves four suggested incremental phases shown in Figures 2 and 3:

Figure 2 – Talega Substation Alternative

Source: The Nevada Hydro Company

Figure 3 – Single Line Diagram of Extension to the TE/VS Interconnect



Source: The Nevada Hydro Company

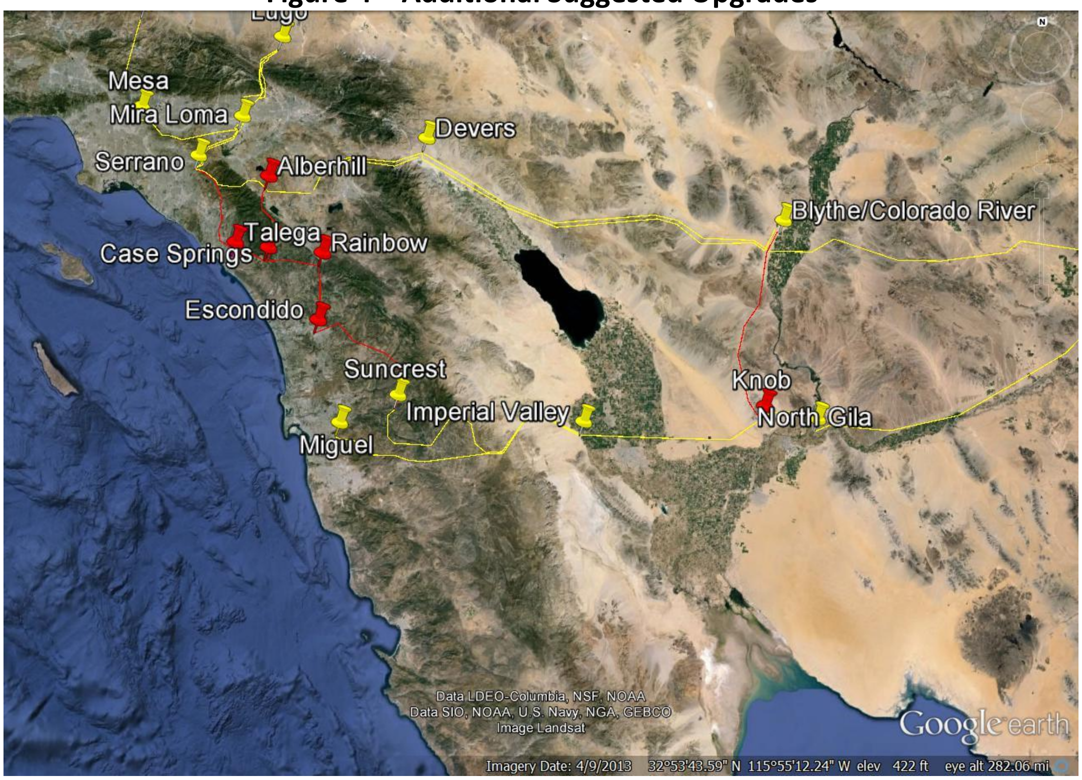
1. Extend a 500 kV line from Case Springs to Talega Substation.
2. Install two 500/230 kV transformers in a new area to the west of the existing Talega Substation. Figure 2 – Talega Substation Alternative shows a Google Earth view of the area with this reconfiguration shown.

3. Loop in SCE's four 230 kV lines from SONGS to Viejo, Serrano, and Santiago (2 circuits). Figure 3 – Single Line Diagram of Extension to the TE/VS Interconnect shows this revision.
4. Extend a 500 kV line from Case Springs to Escondido. Install two 500/230 kV transformers. Additional study will be required to determine the size of the transformers and whether phase shifters may be required.

B. Additional Upgrades that should be considered

Beyond the TE/VS Interconnect with its various options, Nevada Hydro has other suggestions. Figure 4 – Additional Suggested Upgrades shows these suggested additional upgrades.

Figure 4 – Additional Suggested Upgrades



Source: The Nevada Hydro Company

1. Inclusion of a 500 kV substation at SDG&E's proposed Rainbow Site

An expansion to the 500 kV build–out of the TE/VS Interconnect would be to add a 500/230 kV stepdown at Rainbow. This would also provide a prospective interconnection point for gas-fired combined cycle generation in that vicinity.

2. Construct a 500 kV line from Escondido to Suncrest

This line would complete the connection at 500 kV from the Valley area to the Imperial Valley area. Consequently, any N-1-1 contingency event would still keep at least one 500 kV supply into the San Diego load area.

3. Rebuild the 230 kV line from Serrano to Talega for 500 kV

The present 230 kV from Serrano to Talega was originally considered as an alternative to the Valley-Rainbow Project for rebuilding at 500 kV. However, by integrating such a rebuild with the option of having 500 kV at Talega as part of the TE/VS Interconnect, a second 500 kV circuit would exist into Talega. This would provide 500 kV service into the interface between SCE and SDG&E at Talega under any N-1 contingency and more robust supply to the San Diego and L.A. Basin in general. If this addition happens after completion of the suggested Escondido-Suncrest 500 kV line, there will be at least one 500 kV line into Case Springs for any N-1-1 contingency and one 500 kV substation supplying power into the two basins.

4. Convert the 161 kV line from Blythe to Knob to 500 kV

While the Alberhill-Case Springs-Escondido-Suncrest series of lines would close the gap between the 500 kV system in the Devers-Valley-Serrano area on the north, and the Miguel, Suncrest, Imperial Valley area on the south, the loss of one of those interconnecting segments would cause a large angular difference between them. It also puts the need for any loop flow on the 500 kV system to have to go back to Palo Verde-Hassayampa. This has high losses effects besides the problem of reclosing across a large angular difference. The problems of renewable and other resource flows would be reduced by rebuilding the Western Area Power Administration's 161 kV line between Blythe and Knob on the west side of the Colorado River for 500 kV service. In 1998, NRG Energy approached WAPA about making such a conversion. WAPA was agreeable at that time with the conditions that its load responsibilities along that right-of-way be met.

VI. Conclusion

The above outlined projects provide considerable reinforcement to the transmission system into the L.A. Basin and San Diego. They are likely to be enough to meet the delivery needs well into the next decade. This will offer the utilities and CAISO enough breathing space to develop plans that have yet to be uncovered, but are likely to exist if there is enough time to think through the options before the next crisis strikes.

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