TECHNICAL BRIEF

Imperial Valley Dynamic Loss Compensation

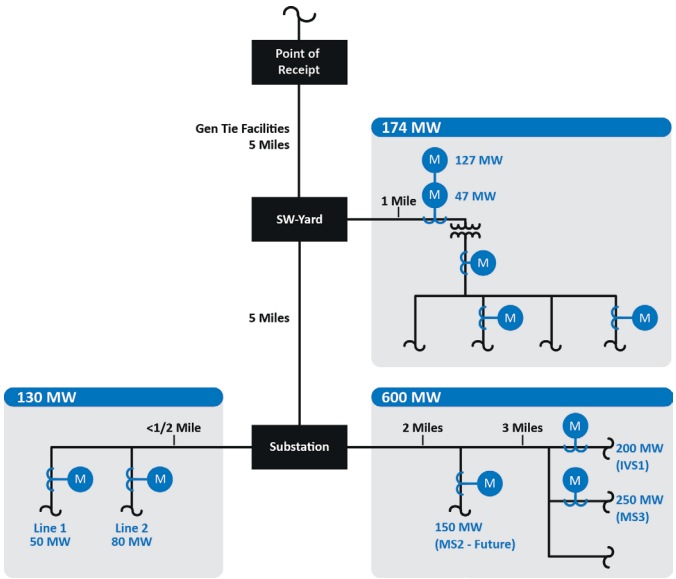
Overview

- Background on the Loss Compensation System
- Advantages to calculating system losses dynamically
- CAISO will accept simplified testing for new resources

To avoid building new generation tie lines to connect photovoltaic (PV) resources to the grid, many project developers locate solar power generation sites near existing transmission lines. In the Imperial Valley of California, this situation resulted in multiple sites sharing a shared gen-tie line. Each resource is connected at a different distance from the point of interconnection (POI). For example, one site is located about six miles from the POI while other sites are more than 12 miles away.

While this approach minimizes construction costs and the environmental impact of building new tie lines, it means that resistance and associated losses are different for each site according to the physics of power transmission described by Ohm's law. Adding further complexity to the loss calculation, each site's output changes frequently based on irradiance and curtailment orders. The complexity of loss calculations is further compounded because energy payments for the sites are divided among six power purchase agreements.

Determining line losses by applying static formulas is inadequate in situations like this because a fixed approach doesn't account for the variable impact of each resource throughout the day. To address these challenges, and ensure accurate settlement values, Trimark collaborated with CAISO, IID, SCE and all resource owners to develop a dynamic loss system to measure and document real-time losses for these resources.



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Imperial Valley Loss Compensation System

Overview of the Imperial Valley Loss Compensation System

The Imperial Valley Loss Compensation System was designed to measure output for sites that share a generation tie line and dynamically assign accurate line loss values based on generation status and distance from the POI. The system measures actual losses in real time based and reports resulting values to CAISO for settlement purposes. While maintaining confidentiality, each resource owner each resource owner can view, analyze and report losses for their resource through a monitoring system.

The original Imperial Valley Dynamic Loss Compensation System was commissioned in 2012 to serve Imperial Valley Solar 1 (Mt. Signal 1), Centinella, and CSolar South. With the upcoming addition of Mt. Signal 3 and Mt. Signal 2, the loss compensator will meter and allocate losses associated with more than 904 MW of solar power generation.

The Imperial Valley resources connect to the Imperial Valley Substation, the location where the CAISO Point of Receipt (POR) resides, through the Drew Substation, have shared line losses on the 230kV line leading to the POR.

System Architecture

The architecture of the Imperial Valley Dynamic Loss Compensation System includes two identical systems – a primary and backup -- to provide redundant measurement, historization and data telemetry. Each system includes a Loss Compensator server, two CAISO-certified revenue meters for each resource, a firewall at each resource, and a fiber ring connecting them. There are also meters at the Point of Receipt.

The Loss Compensator server gathers data from the revenue meters, calculates losses for each individual resource in real-time, and then sends that information back to the corresponding meters. If communication to a primary meter is lost, the primary Loss Compensator will read the backup meter data from the Backup Loss Compensator to perform its calculations. This ensures consistency between data in both the primary and backup systems. In the event that communication is lost to both the primary and backup meter, all parties agreed that the Loss Compensator servers will default to a predetermined generation value and a static loss value. If this were to ever occur, the system assumes that the resource is generating at full power and will calculate losses for all resources based on that assumption. Similarly a meter that has lost communication with its Loss Compensator server will record losses calculated with the assumption that all other resources are generating at full power.

Alternative Loss Approach

The CAISO alternative to a loss compensation system also uses the assumption that all resources are generating at full power. A resource meter would have no knowledge of the total current on the 230kV line segments. Instead, the meter would use theoretical current values for the other resources calculated from their name plate capacities.

By basing loss calculations on measured conditions rather than a static loss value, resources can profoundly improve revenues. Trimark recently analyzed the difference between using a static loss value and calculated loss values using measured losses. The difference between the two calculations was more than 5000 Megawatt hours for just one, 130 MW resource.

Joining the Imperial Valley Loss Compensation System

If a new resource, connecting through the Drew Switchyard, wishes to come online and start generating, CAISO will require that the additional losses, incurred by the existing resources due to the new resource, be accounted for by all participating metering points throughout the loss compensation system. This will require one of two things:

1. The new resource must be integrated into the existing loss compensation system using the same methodology for calculating losses as before.
2. The existing loss compensation must be modified to use static current values for the new resource based on its full generation name plate capacity.

In either scenario, modifications to the loss compensation system must occur. This includes modifications to the Loss Compensator servers as well as each individual meter. With the first option being highly accurate and the second option erring towards the worst case for losses, it is in the interest of both new and existing resource owners to implement the first option as that option has proven to provide the most accurate accounting of losses for settlement.

Additionally, the cost for the necessary modifications will be covered by the new owners with that path taken. If new resources chose option 2 and do not integrate into the existing loss compensation system, the system must

still be modified and the costs associated with those modifications would fall to the existing owners.

The Imperial Valley Dynamic Loss Compensation System was designed so that new resources can easily be added into the calculation in order to maintain accurate revenue data for settlement purposes.

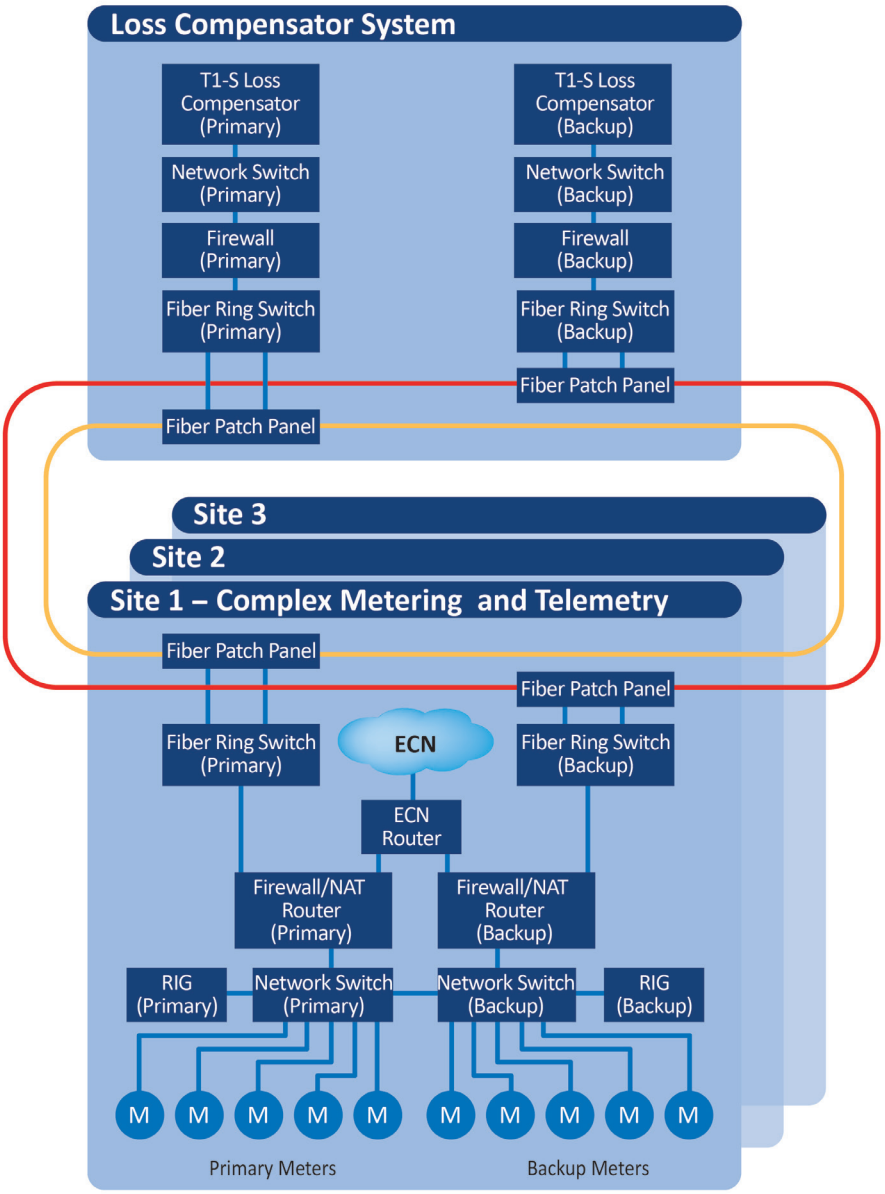
During the addition of a new resource, Trimark will leverage the parallel redundant architecture to facilitate the change. By temporarily blocking communication between the primary and backup servers, either system can be reconfigured and tested without affecting the other system. Trimark will reconfigure and test the backup system first. Once internal testing and external testing with the CAISO has been completed on the backup system, we will modify the primary system.

The CAISO RIGs read data from both the primary and backup meters. That data is fed into redundant source calculations before being passed on to CAISO. In order to maintain accurate real-time telemetry, the meter data connection to the system being worked on is simply disabled. This will require an OMS telemetry outage but will not require any additional testing with the ISO.

The testing performed with the CAISO during commissioning was rigorous. Meter inspectors and test sets were used to simultaneously inject current into the meters at each resource. Multiple test cases emulating a variety of generation scenarios were applied both in the lab and in the field. Following commissioning, the loss compensation system has operated exactly as designed since 2012.

Based on the long-term success and availability of data to support thorough analysis and testing, CAISO's EDAS group has verbally agreed that the level of testing applied to the initial system will not be required when new sites are added to the Imperial Valley Loss Compensation System.

Specifically, instead of using simultaneous current injections, CAISO has agreed that production data can be used during testing. This approach will simplify system configuration and testing by reducing the personnel, equipment, and coordination required to confirm accurate calculations and data telemetry.



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