Planning, Monitoring, and Evaluating the Living Pilot with Distribution Line Monitoring

Proposal Prepared by Sentient Energy for the
California Public Utilities Commission &
Southern California Edison
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The Proposal

For Preferred Resources to meet local capacity needs, Southern California Edison (SCE), the California Public Utilities Commission (CPUC), and the California Independent System Operator (CAISO) must have confidence that the resources will have an impact. Appropriate load monitoring technologies are critical to ensure that the proposed Living Pilot will achieve its objectives at a reasonable cost while maintaining the local and regional distribution network's reliability. Sentient believes that communicating distribution line monitors offer the most attractive solution, balancing cost with operational value. Sentient recommends that SCE include distribution line monitors in the application it files seeking funding for the Living Pilot, and urges the CPUC to approve funding for this purpose.

Challenges

SCE currently estimates that load will grow by about 250 megawatts in the Johanna and Santiago areas over the next decade.

Assuming that the load growth is offset by an equal mix of energy efficiency, demand response and distributed generation, Sentient estimates that approximately 150,000 residential customer and 2,500 commercial and industrial customers will need to deploy a Preferred Resource. Planning, procuring, operating and monitoring so many distributed resources creates challenges on an unprecedented scale:

- Existing load measurement tools cannot measure the operational performance of distributed resources on a real-time basis. Substation metering aggregates too many customers and customer advanced meters use large time intervals and deliver data far too late for operational decisions. Without sufficient confidence that distributed resources are performing, the CAISO must fall back on over-procuring backstop capacity and energy, raising costs for SCE's customers.
- High penetration of solar photovoltaics on distribution circuits will result in significant voltage fluctuations, especially during low load periods (e.g. April/May afternoons) and on high impedance circuits. If unaddressed these voltage fluctuations can damage customer and utility equipment.
- Distribution system reliability will become more critical on high generation/low load circuit segments, yet reliability will be more difficult to maintain as distributed generation prevents traditional fault location methods from working.

How Line Monitors Address the Challenges

Distribution line monitors address each of these challenges by providing the needed data resolution with minimum data latency. Substations can provide load data but on a highly aggregated basis. SCE's "A" substations aggregate hundreds of thousands of customers, and its "B" substations aggregate thousands of customers. Line monitors target circuit segments, thereby grouping only tens or hundreds of customers. This data resolution is critical when generation and load relief is provided on a customer-by-customer basis.

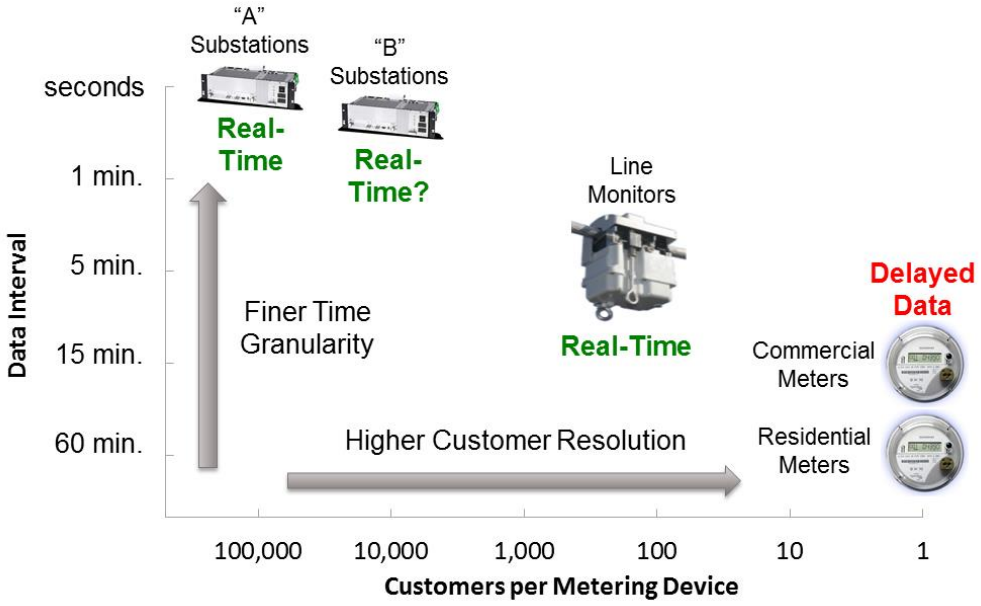
Distribution line monitors integrate sensors, computing and communications. Line monitors can measure characteristics of current and voltage. The monitors power themselves off of the power line and can communicate continuously, providing real-time load flow, generation, and demand reduction data. Line monitors are cost effective so multiple devices can be deployed on a primary feeder, providing detailed load monitoring and pinpointing faults.

Line monitors address specific challenges SCE will face in the Living Pilot:

- Line monitors provide current data in small time intervals for a reasonably small population of customers with low latency. This addresses the operational needs of SCE and the CAISO and substantially reduces the uncertainty introduced by relying on highly aggregated "A" substations.

  From an evaluation standpoint, line monitors provide data at a level that can be used for mid-course evaluations of distributed preferred resources to improve subsequent deployment.

  The following diagram depicts how line monitors strike a balance between customer resolution and time granularity:



- On circuits with high solar penetration, line monitors can determine the impact of solar photovoltaics on circuit voltage and identify where the utility may need to target voltage regulation investments to remain within regulatory standards. Line monitor data can also be used by utility interconnection planners to support higher penetration of solar on some circuits.

- Line monitors are highly effective at fault pinpointing, which will enable the utility to locate outage-causing faults, even when fuses and other traditional protection equipment do not operate predictably due to distributed generation. This will ensure distribution reliability is sustained or even enhanced by the Living Pilot.

The table below uses SCE's taxonomy to further describe additional ways line monitors support each type of Preferred Resource:

Attribute Class	Description	Program Example	Line Monitor Benefit
A	Firm Load Reduction	Energy Efficiency Peak Load Reduction; Permanent Load Shift	Better impact monitoring. Complements bottoms-up EM&V studies.
B	Customer Side Intermittent Generation	Customer Rooftop Solar	Use true circuit loading to accelerate interconnection process and justify higher penetrations. Monitor circuit loading, current direction, and voltage.
C	Real Time Demand Reduction	Energy Storage Device; Direct Load Control	Provides real-time determination of load impact at the circuit level. Improve ex post evaluation.
D	Scheduled Load Reduction	Demand Response (BIP); Demand Response (SDP); Demand Response Contract (with dispatchable EMS)	Provides real-time determination of load impact at the circuit level. Improve ex post evaluation.

Deployment Recommendation & Cost

Sentient recommends that SCE place monitors adjacent to each switching location on SCE's primary feeders. Switches are strategic locations because they typically define similar sized blocks of customer load and are locations where the utility can take operational actions in response monitoring. Additional sensors may be justified at large tap lines and at significant distributed generation and storage locations.

Line monitors can also be deployed on the sub-transmission lines that connect "A" and "B" substations, especially to monitor any customers or distributed resources that are connected directly at the sub-transmission level.

Based on Sentient's estimates, SCE should deploy at least 2,300 line monitors, which would cost less than one percent of the total pilot cost.[1]

Contacts:

Andrew Campbell
Director of Regulatory & Business Analysis
acampbell@sentient-energy.com
(415) 515-4655

Dennis Perrone
Account Executive
dperrone@sentient-energy.com
(775) 233-7639

[1] Sentient's calculations assume the Johanna and Santiago areas have 32 "B" (i.e. distribution) substations, six feeders per substations and four switch locations per feeder.