Title of Proposed Initiative: Real-time Monitoring of Distribution Grid Power Quality (PQ)

Investment Areas (Check one or more)
X Applied Research and Development
X Technology Demonstration and Deployment
Market Facilitation

Electricity System Value Chain (**Check only one**)**:**
Grid operations/market design
Generation
Transmission
X Distribution
Demand-side management

Issues and Barriers:
Power quality and reliability are critical for commercial and industrial customers, especially within the rapidly growing high-technology sector. Sub-second voltage dips, swells or outages can shut down essential equipment, and interrupt software and hardware product development, testing, and production processes. At the same time, power quality and reliability are expected to become more challenging to manage in the future – with expanded use of variable renewable resources such as solar and wind at a utility scale, and more intermittent and significant sources (e.g. solar) and loads (e.g. EV charging) on the distribution grid.

Historically, power reliability has been measured in terms of the frequency of power outages lasting longer than 5 minutes. Momentary outages, defined as zero voltage events lasting for less than five minutes, are measured via MAIFI [Momentary Average Interruption Frequency Index]. Yet sustained and momentary outage metrics don't reflect the full range of power disturbances that result in customer impacts.

Power quality is further defined as 'any occurrence manifested in voltage, current or frequency deviations which results in failure or mis-operation of end use equipment.' Sub-second voltage dips or swells greater than 30% of nominal often also result in customer impacts, as defined by indices such as the CBEMA-ITIC curve. And typical of many commercial and industrial zones with older utility infrastructure, such power quality disturbances can occur regularly. Momentary outages can represent a material business issue, as an EPRI study found the average impact of a one-second outage for a commercial facility was 21 minutes in downtime.

With advancements in metering technology, many major energy customers have recently implemented high-resolution power quality meters at their service entries. These meters gather extensive data related to power usage and power quality. Yet utilities generally do not have visibility to this level of detailed power quality data beyond their substations. For the utility, it can be difficult to quickly assess some power quality events as reported by customers in the distribution network. It is challenging to correlate and communicate power quality events, understand customer impacts, and identify and isolate root-cause issues in the power network that may be far removed from a particular reporting customer.

Even for a commercial customer with a high-resolution PQ meter it difficult to quickly determine if an event was unique to their building, circuit/feeder, substation, transmission area. Customer response depends upon this information. And for customers without PQ meters, it is difficult to recognize some PQ events at all. Related equipment malfunctions can go unexplained, making it impossible to 'harden' key physical assets and improve event ride-through.

Initiative Description and Purpose:
This proposed initiative would establish an area-wide demonstration project to implement a power quality monitoring system aggregating new detailed data from high-resolution customer meters. The demonstration would be best located in a commercial and industrial location where customers have self-identified power quality as especially important, where there is some potential for actual power quality issues, and where there is a high penetration of distributed generation and EV charging. The system would collect power quality event data and other related data from instrumentation at selected customer locations, as well as qualitative input on events and customer impacts area-wide.

The project would include an online, real-time power quality monitoring 'portal' to provide the utility and registered customers in the area with an immediate view of incident data. This would include plots of incidents over time versus selected power quality standards such as CBEMA-ITIC or P1668, and on a geographic overlay. The project would also include an integrated, regional power delivery network map and simulation overlay to provide the ability to map incident data to the transmission and distribution network and apply simulation tools and analytics to support investigation and remediation and upgrade justification as appropriate. It would also provide access to root cause information when determined.

The project could also potentially incorporate utility network line sensing and fault location features to assess their value in predicting, isolating and mitigating PQ incidents that are the focus of this initiative. Additionally, the project could incorporate features for active management of customer premise devices such as PV inverters, EV charging stations, and customer loads to assess their value in mitigating PQ incidents that are the focus of this initiative.

To support such a regional project, $2.5 million in funding would be required for deployment of new and/or configuration of existing power meters at 30-40 strategically located customer metering sites in across a regional power delivery network, supplemental network monitoring and device monitoring, development and implementation of supporting databases and online portal software, development and implementation of network models and associated software, associated data exchange and process development with local IOU and/or municipal utilities, research, results analysis and M&V activities.

Stakeholders:
Such a concept is currently under local development, with proof-of-concept implementation of some features now live in the Silicon Valley area. Support has come from major commercial energy customers (NetApp, Juniper Networks, Moffett Park Business Group), utilities (PG&E, Silicon Valley Power), and solution providers (Advanced Power Technologies, Accenture).

Background and the State-of-the-Art:
Under Joint Venture Silicon Valley's Smart Energy Enterprise Development Zone (SEEDZ) Initiative, energy stakeholders in Silicon Valley collaborated to develop the proof-of-concept 'SEEDZ Power Quality Portal'. The system receives and aggregates real-time power quality incident data from selected customer-premise power meters, and presents the data in an online format immediately visible to system subscribers in the area. This proof-of-concept has been successful in raising customer understanding of power quality, its measurement and impacts,

and has provided utilities and customers with access to very specific data with which to help confirm and triangulate power quality events, and isolate root causes.

Silicon Valley Power (SVP), a participant in the SEEDZ PQ Portal proof-of-concept, has employed a PQ monitoring and notification system for several years. This has been popular with its major commercial and industrial customers. Using PQ data from its substations and other select metering locations, SVP notifies customers when it registers a PQ event, and solicits impact data. This service has been useful to SVP in identifying and justifying needed grid improvements. In the portal proof-of-concept, SVP is looking to collect additional data from customer premise meters, providing incident data and collecting impact data in an online format.

Ultimately, such a capability facilitates collection of new streams of customer-premise data, and creation of a rich new dataset for improvement of power quality and resiliency in the area. An area-wide PQ monitoring system can incorporate leading smart grid PQ standards, and enable the demonstration area to serve as a model and real-world test bed for grid integration of distributed generation, electric vehicles, and advanced industrial uses.

Justification:
Improved processes for collecting, analyzing and communicating rich new streams of customer-premise power quality data, and aligning it with grid conditions will increase understanding of distribution grid performance, and help to better pinpoint and justify needed improvements and expand options for grid performance improvement. It will also facilitate a more detailed understanding of the impact of distributed energy resources and the deployment of electric vehicle charging stations on the grid as well as their active participation. Utilities will be able to provide their customers with more rapid and accurate incident information. Additionally, online mechanisms for collection and presentation of incident data will reduce utility customer service call handling requirements, reduce impact data collection costs, and improve data quality.

Ratepayer Benefits (Check one or more):

X Promote greater reliability
X Potential energy and cost savings
X Increased safety
Societal benefits
X Environmental benefits [facilitates maximum DER penetration on distribution grid]
X GHG emissions mitigation/adaptation in the electricity sector at the low cost
X Low emission vehicles/transportation
Waste reduction
X Economic development

Public Utilities Code Sections 740.1 and 8360:
Consistent with the Public Utilities codes noted, this proposal would increase use of new, cost-effective, customer-provided digital information and control technology to improve reliability, security, and efficiency of the electric grid. It enables improved optimization of grid operations and pinpointing of specific problem areas in the distribution grid by providing and expanded set of performance data that spans the distribution grid. The best demonstration site for a real-time PQ monitoring system is a distribution grid with sophisticated commercial and industrial energy demands, and high penetration of distributed resources and generation. This enables the

demonstration area to serve as a model and real-world test bed for grid integration of distributed generation, electric vehicles, and advanced industrial uses.