Energy resiliency through crowdsourced power quality

Hawaii's nation-leading penetration of distributed photovoltaics has created concerns related to power quality and grid stability with significant technical, social, and economic dimensions. This creates opportunities to investigate how a rapidly deployable, low cost approach to crowdsourced power quality data collection can improve the resliency of electrical grids.

The objectives of this project are to design, implement, and evaluate a combination of low-cost open source hardware, software, and data that provides new visibility into end-user power quality (voltage, frequency, and total harmonic distortion). The project provides data regarding household and/or neighborhood power quality events, how these events relate to other environmental phenomena, and recommendations regarding appropriate action to take.

The methods include evaluation of the system through a case study experimental design involving deployment into 150 households in Hawaii. It will assess the extent to which crowdsourced power quality data can improve energy resiliency by detecting, monitoring, predicting, and diagnosing grid problems.

This project will produce innovations including: (a) low cost, open source hardware for residential power quality monitoring of voltage, frequency, and total harmonic distortion; (b) an open source cloud-based repository for storage, retrieval, and analysis of this data along with environmental data including temperature, humidity, lightning, and insolation; (c) the addressing of privacy concerns by allowing consumers to "coarsen" locational information; (d) the use of a pre and post-test experimental design in order to gain insight into the effect that power quality data has upon consumers.

The project will test the following hypotheses: (1) Knowledge of personal power quality problems leads to actions such as contacting the utilities, installing UPS, or unplugging on alerts; (2) Intrinsic motivators (insight into personal and neighborhood power quality) plus a free device will suffice for participation in crowdsourced data collection; (3) Knowledge of neighborhood power quality issues leads to active engagement with neighbors; (4) Consumers find the recommendations provided by the system to be useful; (5) The frequency and severity of events is positively correlated with the degree of penetration of distributed PV on that circuit; (6) Consumers find crowdsourced power quality data to be more useful than their own power quality in isolation; (7) Participation is positively correlated with high monthly bills, installation of rooftop PV, or high numbers of severe PQ events.

Our completed system will enable any community to rapidly deploy a low-cost mechanism for end-use power quality data collection and analysis. Our project will test hypotheses enabling communities in future to make the best use of the data.